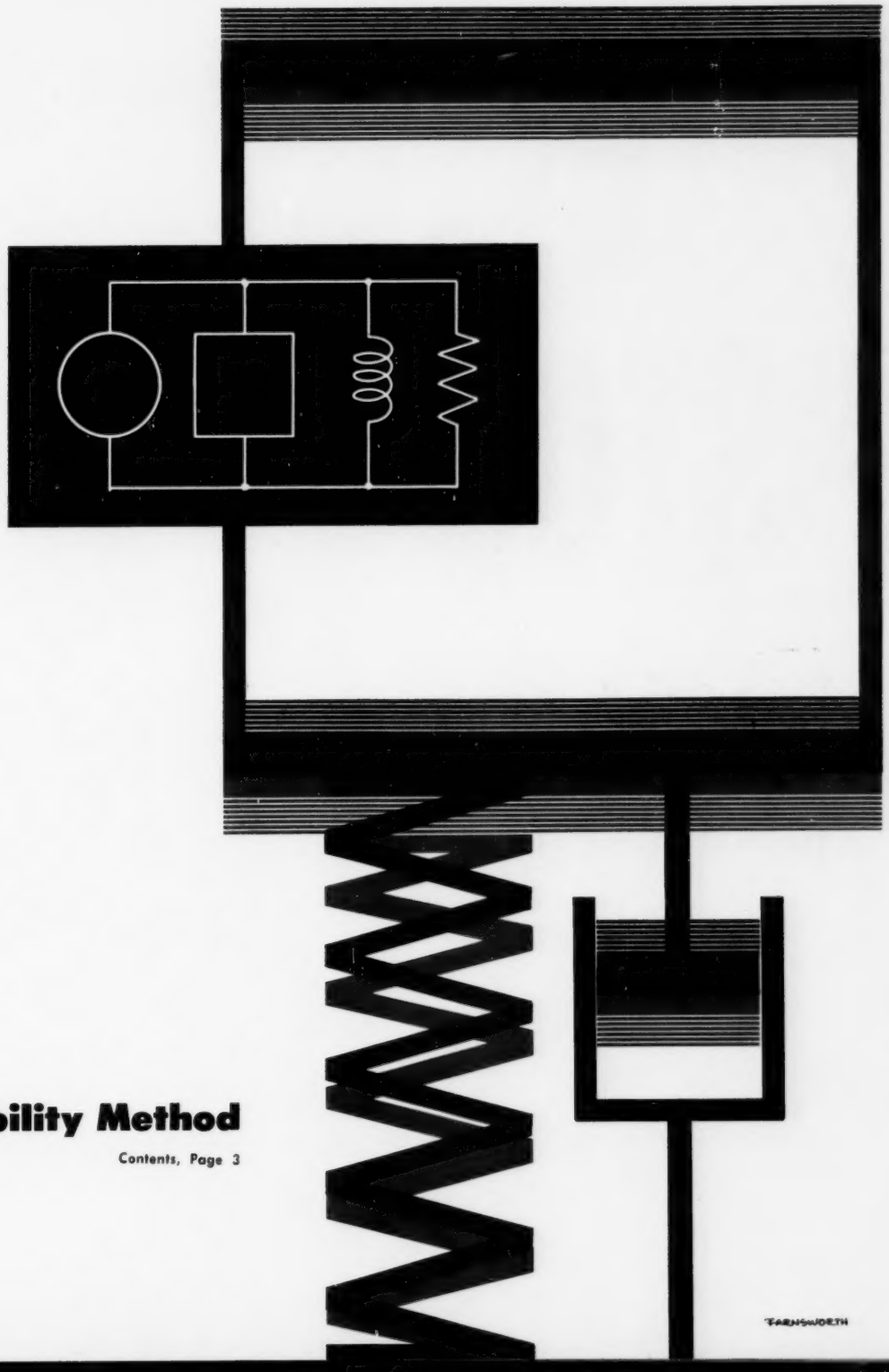
DECEMBER 10, 1959

MACHINE DESIGN

A PENTON PUBLICATION — BIWEEKLY



The Mobility Method

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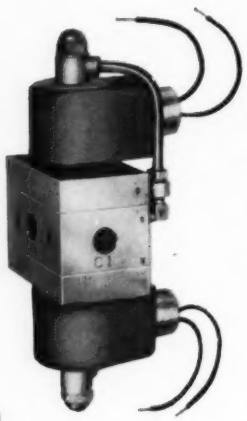
New 3 Position,
4 Way Solenoid Valves
Feature Dead Tight
(Poppet Type) Seating

ELIMINATE PISTON DRIFT



ASCO's new 3 position 4 way (Bulletin 8347) permits no leakage on air or liquids, assures precision positioning and positive locking of cylinder piston. Graduated (inching) or full stroke of piston may be obtained by regulating the length of time each solenoid is energized. When both solenoids are de-energized, the valve assumes a center position. All orifices are blocked, locking the cylinder piston at any point in the stroke.

Simple valve design (only moving parts are 2 solenoids and 4 diaphragms) and overall rugged construction provide millions of trouble free operations. These new valves can be mounted in any position, are available in ¼" and ⅜" pipe sizes, handle air, water and oil at pressures to 250 p.s.i. Bulletin 8347 Valves are stocked for immediate delivery.

ASCO Solenoid Valves are stocked at the Florham Park Factory, and at warehouses in Chicago and Los Angeles. **WRITE** for catalog literature on the new Bulletin 8347, and for the new ASCO Stock List and Selection Guide (Publication 506) listing the world's largest stock of solenoid valves for immediate delivery.

ASCO Valves

Automatic Switch Co. 54-A HANOVER RD., FLORHAM PARK, N. J., FRONTIER 7-4600

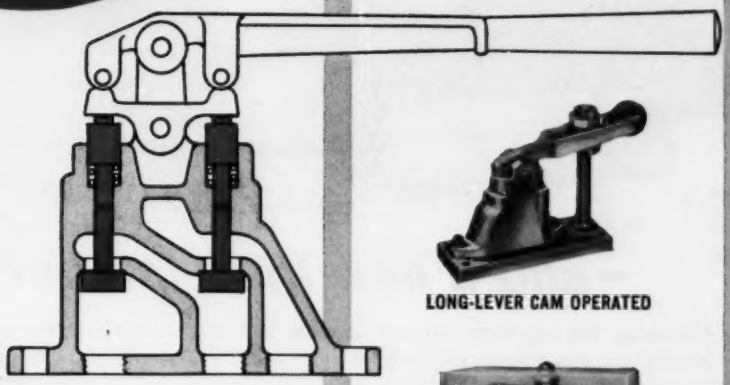
AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL

ASCO®

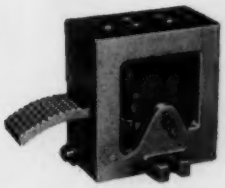
Circle 401 on Page 19

Give this valve your *ROUGHEST* jobs!

Ross
"100" Series
TOUGH-DUTY VALVE



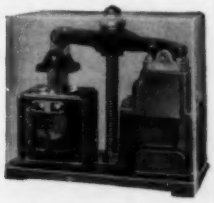
foot, cam, solenoid versions available, too



FOOT OPERATED

ROLLER CAM OPERATED

LONG-LEVER CAM OPERATED



SOLENOID DIRECT OPERATED

Steel mills, foundries, mines, offshore drilling, logging . . . these industries love the Ross "100" Series valve. Here's why: It performs well wherever you need a manually operated valve, but it is really the finest, most dependable valve available for use where the environment is rough and tough. The "100" Series valve will pass most dirt and foreign matter with no trouble and has only a few moving parts. Its poppets travel only a scant fraction of an inch, so it is especially wear resistant. It transmits a "feel" of control to the operator so he may "inch" a cylinder with fine control. Available in locking or non-locking, 3 way or 4 way, closed or cracked-to-exhaust-center models, with handle normally upright or horizontal. Write for further information.

STAY AHEAD
MODERNIZE

Ross OPERATING VALVE COMPANY
109 EAST GOLDEN GATE AVE. • DETROIT 3, MICH.

Circle 404 on Page 19

Another blueprint of better design–

–and a new idea in shock dampening!

Absorbing the crashing impacts between 120-ton freight cars was a tough job for even the heaviest of helical steel springs. So this big railroad equipment-maker decided to investigate the possibilities of rubber in designing a new kind of coupling draft gear.

The Goodyear experts then went to work with the equipment manufacturer's engineers. Soon they had come up with a new rubber compound of amazing toughness – molded it into shock-absorbing rubber-to-metal sandwiches, nine to a set.

Result: a new draft gear that provided far more impact-protection than anything else on the market. Its recoil, for example, was only 18% – a low never reached before. It was, in fact, the first draft gear of its type ever to be approved by the railroad lines' own certifying agency.

Credit another success, then, to the resourceful technicians, in the well-equipped Goodyear molded/extruded plants, who have solved shock absorption and vibration problems in a wide range of equipment for many industries. To talk over your own molded/extruded rubber requirements – contact your local G.T.M.–Goodyear Technical Man. Or write directly to Goodyear, Industrial Products Division, St. Marys, Ohio, Los Angeles 54, California, or Akron 16, Ohio.

MOLDED OR EXTRUDED GOODS BY

GOODYEAR

THE GREATEST NAME IN RUBBER

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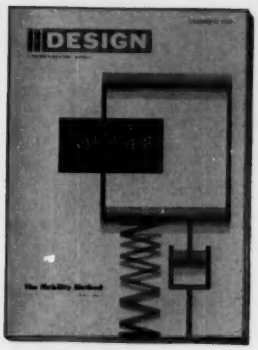

Front Cover: The classical single-degree-of-freedom case in vibration is given a new look by artist George Farnsworth. And for a new look at how to attack the problem, try Dick Thorn's article, Page 144.

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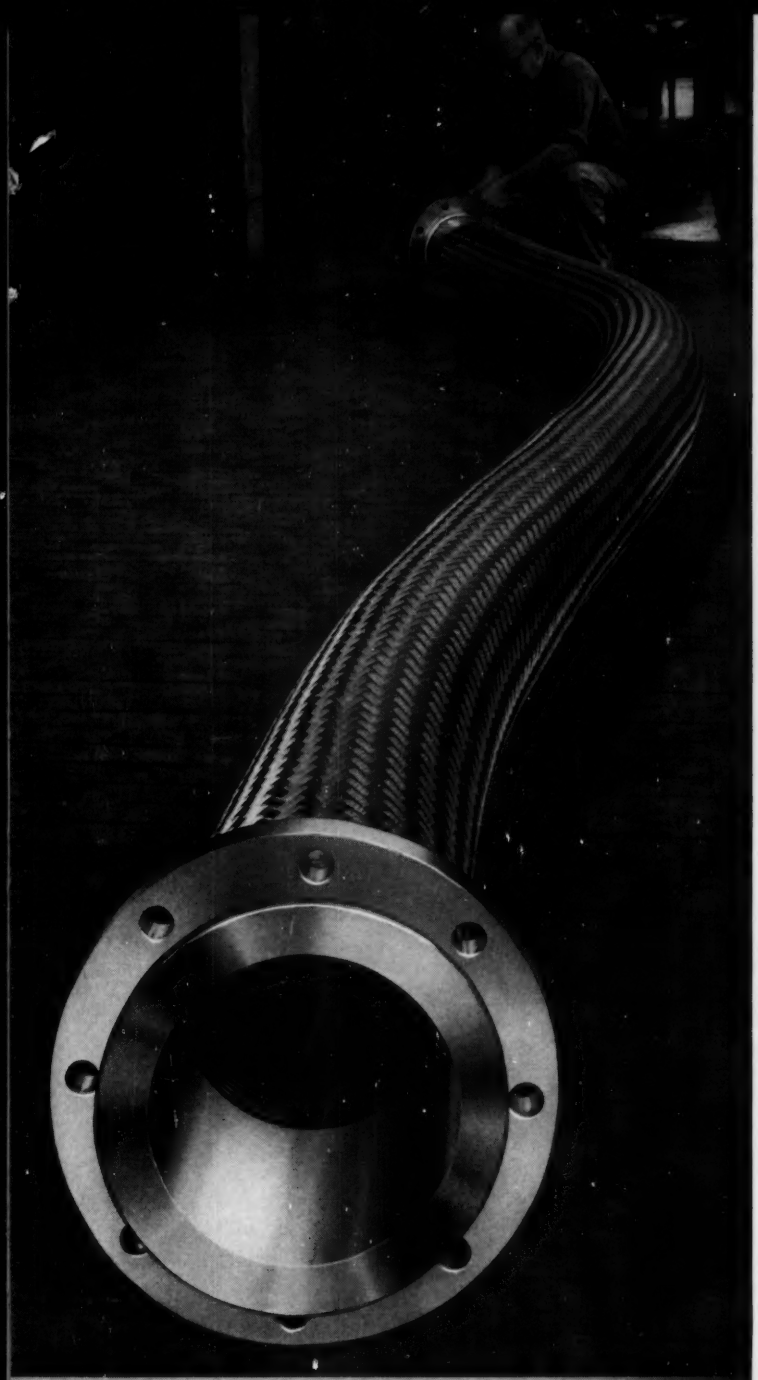

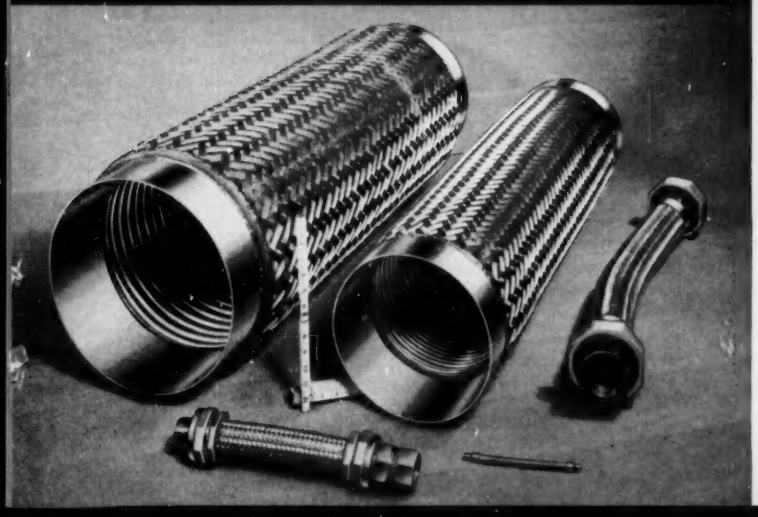

BIG OR SMALL

FLEXIBLE TUBING ANSWERS TO TOUGH PROBLEMS

The flexible metal tubing assemblies on this page give an indication of the scope of facilities at Anaconda Metal Hose for designing and manufacturing tubing answers to tough problems.

The big 16½-foot, 8-inch diameter tube in stainless steel at the left was built for handling liquid oxygen in missile ground handling equipment. In the photo below, left rear, are two stainless steel connector assemblies—14-inch and 10-inch I.D.—also used in handling liquid oxygen.

From such assemblies down to the tiny ⅛-inch I.D. Vibration Eliminator shown in the foreground at the bottom of the page, the variety of flexible hose assemblies—in size, material, and design—is almost infinite.

FREE TECHNICAL SERVICE. Anaconda Metal Hose specialists are constantly working with design engineers on special flexible connectors and hose to meet new problems. Having broad experience working in stainless steel, other steel alloys, Monel, copper alloys, aluminum, and Teflon,* they can save you considerable time and money in designing the flexible connector best suited for your needs.

Our specialists are available to you through Anaconda Metal Hose representatives in leading cities — see listing "Metal Hose" in the Yellow Pages. Or write: Anaconda Metal Hose Division, The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. *Registered trademark for Du Pont fluorocarbon resins.

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ANACONDA®
METAL HOSE

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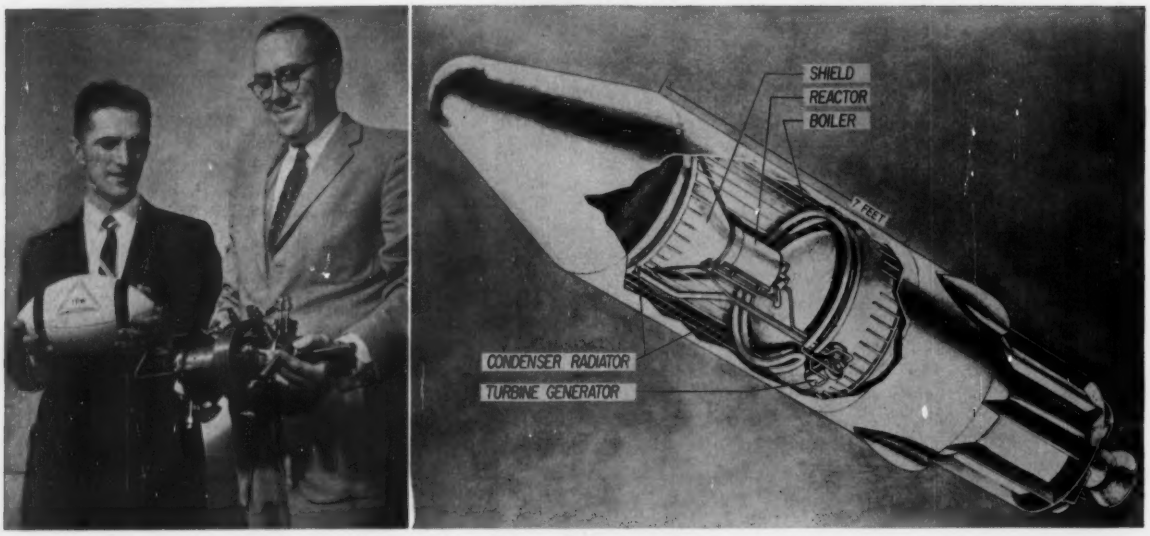
ENGINEERING NEWS

Snap II: Nuclear Powerplant Fit for a Satellite



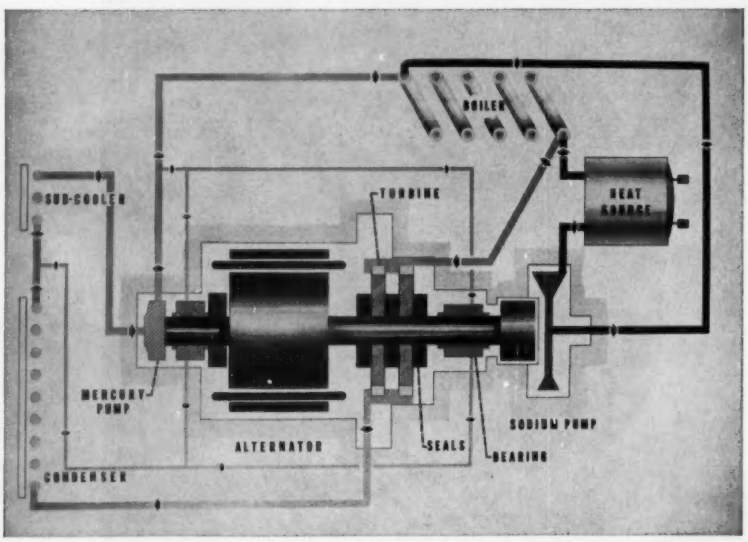
Rotating machinery for Snap II (left) is designed to operate indefinitely in a highly corrosive environment. Rates of mass transfer have been carefully calculated to produce a finely balanced mechanism which will not disturb the orbiting attitude of the carrying vehicle. The reactor (right) shown as it might be installed in a satellite, is about the size of a 5-gallon milk can. It produces 5 kw of heat and, as reactors go, represents true miniaturization in the field.

WASHINGTON—AEC's newest success in developing small, high-output electric power sources combines two outstanding engineering achievements:

- A 220-lb nuclear reactor, by far the smallest ever built in the free world. Developed by Atomics International Div., North American Aviation, it contains only 6.6 lb of enriched U-235.
- A 30-lb turbine-generator, which supplies 3 kw of electrical power, developed by the Tapco Group of Thompson Ramo Wooldridge Inc.

According to AEC Chairman John A. McCone, the new device, designated Snap II, could operate for years at a level that would keep at least fifty 60-watt bulbs lighted. It will make possible long-lived weather satellites, world-wide television communication, deep-space information transmission, and eventually interplanetary travel.

Snap II's turbogenerator operates on the same principle as ordinary



Snap II's turbine, driven by mercury vapor, spins at 40,000 rpm. Mercury is also used as the lubricant (on hydrodynamic bearings). The condenser, which will ultimately be part of the carrying vehicle's skin, is backed up by a subcooler to assure complete condensation. This is a critical factor, because any vapor at the mercury-pump inlet would cause cavitation. The sodium pump is a rotating permanent magnet type. Snap's alternator produces 3 kw of electrical power at 2000 cps and operates at 700 F in a mercury-vapor atmosphere.

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. . . Fluid Power news

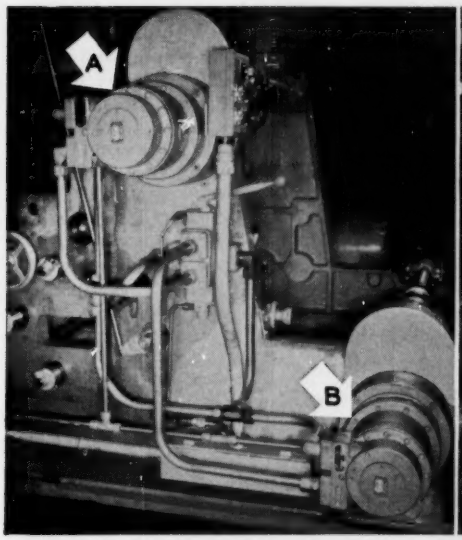
REPORT No. 12,300 HIGH PERFORMANCE WINDER DRIVES

From Oilgear Application-Engineering Files

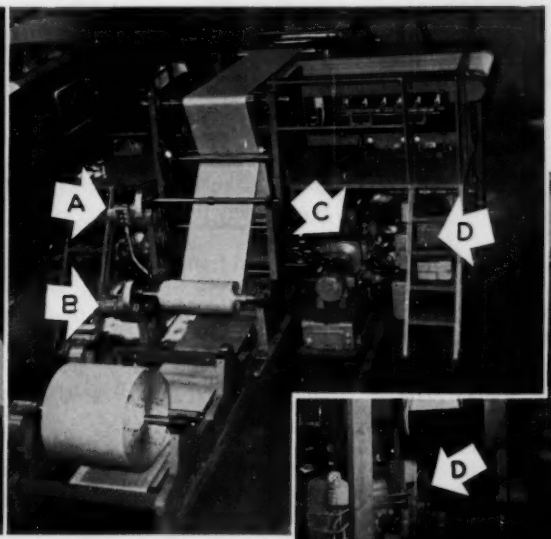
HOW OILGEAR PROGRESSIVE ENGINEERING PACES IMPROVEMENTS ON "BEMIS" MACHINES

CUSTOMER: *Bemis Bro. Bag Company, St. Louis, Missouri*

DATA: To efficiently produce the wide scope of paper, cloth, and polyethylene "Flexible Packaging" for which they are famous, "Bemis" designs and builds their own production machinery. Basically, "Bemis" machines are roll-fed, multi-color printing presses capable of very close register . . . operating from inching speeds of 15 fpm to running speeds of 400 to 1000 fpm. Press runs range from 1000 to 1,000,000 bags. Being roll-fed presses, winder drives and controls were a major problem, as ratios of 5:1 up to 10:1 from core to finished roll diameter are not uncommon. Paper widths vary from 10" to 56", with roll weights from 1000 to 2000 lb. "Bemis" specified that their winder drives must be compact; easy for shop, maintenance, and operator personnel to adjust, maintain, and understand. All electrical controls must be simple, with standard components preferred. Each machine to have one main control panel, and three or four remote, push-button panels — with some constant indication of load and tension as a desirable feature. Long, trouble and maintenance-free life was also of prime importance along with ease in installation.



Close-up of face-mounted, Oilgear Type "H" Fluid Power Motors (A, B), geared to rewind spindles of newest "Bemis" machine, shown center. Oilgear Type "D" Pump on "Power-Pak" (C) — center photo — supplies Fluid Power for rewind drive.



Newest "Bemis" press during "trial runs" prior to installation. Rewind motors (A, B) to left. Two Oilgear "Power-Paks" (C, D) with Oilgear Type "D" Pumps and Controls can be seen "tucked away" under the dryer section.

View "around-back" of new "Bemis" press dryer section, showing Oilgear Type "D" Pump and Controls on "Power-Pak" (D) which supplies Fluid Power to Oilgear Type "H" Motor (E) for main press drive. See "Note" below on Oilgear Pump (F), direct-coupled to tail-shaft of Motor (E).

SOLUTION: Through a program of constant improvement and engineering teamwork, Oilgear *Fluid Power* Drive and Control Systems have so successfully paced requirements for more efficient production equipment that "Bemis" plants in 16 cities now have 43 machines equipped with Oilgear winder drives. Dancer roll controls are used on 39 . . . 9 more recent installations have "*HYTAC SYSTEM" drives. Two newest machines (one shown above) have Oilgear Type "D" electrohydraulic servo controlled main press drives, and hydraulic servo controlled winder drives. One reason for this ever-increasing use of Oilgear "Any-Speed" drives has been clearly stated as follows: *"We put them in and forget about them . . . some have been operating for over 11 years without service or repair — many loaded to maximum capacity — others have had no oil change in five years"* . . . proof of the statement heard in all industry — *"For the lowest cost per year — it's Oilgear!"* One "Bemis" installation using a HYTAC SYSTEM winder drive handles 40 to 70-lb kraft stock 26" to 63" wide. This winder operates over a 13:1 ratio — from 3¼" diam. cores to 43½" diam. rolls — is limited only by interference on the machine. Of this HYTAC SYSTEM, "Bemis" states — *"Other types of variable speed drives could never do this . . . operating beyond our fondest hopes."*

*HYTAC SYSTEMS — An Oilgear Trademark

NOTE: *An unusual installation feature is partially visible on photo above. Oilgear Type "H" Fluid Power main press drive motor (E) is also direct-coupled to Oilgear Type "H" Pump (F) which supplies Fluid Power to an Oilgear Type "H" Motor — not shown — that drives the dryer fan.*

USER REPORTS — *" . . . exceptionally fine acceleration control . . . smooth creeping and inching speed up to maximum . . . exceptionally smooth running speed . . . are easier to adjust than other drives . . . require less space . . . pressure gage shows load while drive is in operation . . . maintain an adjustable tension from constant tension to constant torque."* "Bemis" — like other users — has found that Oilgear Drive and Control Systems give them constant tension, automatic tapering tension, stall tension, constant torque, automatic tapering torque, or a combination of tension and torque characteristics to meet their every production requirement.

For practical solutions to YOUR linear or rotary Controlled-Motion problem, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

THE OILGEAR COMPANY

Application-Engineered Controlled Motion Systems

1568 WEST PIERCE STREET • MILWAUKEE 4, WISCONSIN

steam-electric generators, except that mercury vapor is used in place of steam. Heat from the reactor is transferred by a liquid-sodium coolant to a boiler containing mercury; mercury vapor from the boiler drives the miniature turbine. Cycle heat is rejected into space by a radiator.

The new power source represents a different approach in AEC's important Snap Program (Systems for Nuclear Auxiliary Power). Snap I (Rankine Cycle engine, using mercury as a working fluid) and Snap III (thermocouple effect) both use radioactive isotopes to produce heat. Little has been released concerning Snap I, but Snap III, which produces only 5 watts of electric power, was heralded as a major breakthrough in the field when it was introduced last year by President Eisenhower. Snap II not only produces hundreds of times more power, but is safer than its two predecessors. The reactor will not go critical until triggered by a ground signal, while radioisotopes are continuously "hot."

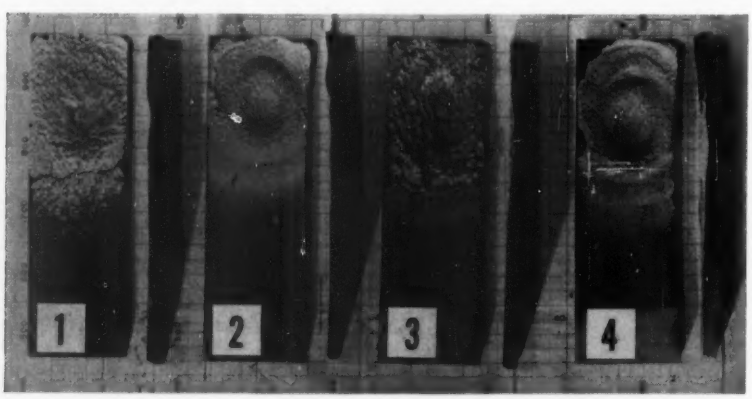
Facing Melts at 3100 F, Forms Liquid Insulation

High-Temperature Sheet Boasts Low Ablation Loss

NORWALK, CONN. — New combination of reinforced plastics and ceramics surpasses both materials in heat and ablation resistance. Not a structural material, the combination, developed by Cordo Chemical Corp., is recommended as a facing for high-temperature resin-reinforced plastics.

Called Resin Bonded Quartz Sheet, it consists of finely divided particles of fused quartz, bonded together with a high-temperature resin. A small amount of glass or other fabric is added to give the sheet good handling properties. The fused-quartz particles have an extremely low coefficient of thermal expansion and their melting point is in excess of 3100 F. When they do melt, the resultant liquid is extremely viscous so that it is not washed off the surface, but tends to act as an insulator. Ablation loss is extremely low.

The sheet is available in thicknesses of from 10 to 20 mils and is 36-in. wide. It costs less and handles as well or better than other extreme-temperature materials. As a facing, it has ample strength for shielding even though it contributes little to over-all structural strength.



These four test panels were exposed to the 5500-F blast from an O-H rocket motor for 60 seconds. Panels 1 and 3 were immersed in cold water immediately after the motor was cut off. Panel 1 (Resin Bonded Quartz Sheet) shows little loss of material, very shallow penetration, and almost complete lack of warpage. Panel 2 (high-silica resin-bonded sheet) warped and crater depth is considerable. Panel 3 (glass fabric with quartz-particle resin) didn't warp or delaminate, but material loss is evident. Panel 4 (high-silica sheet impregnated with a phenolic) warped and a deep crater was formed. All four panels are high-temperature materials. Panels which show cracks were damaged in shipment. They were not damaged during testing.

Topics

Full speed port or starboard will, theoretically, be in the repertoire of a new British ship. The *Oriana,* an ocean liner, is equipped with a transverse propulsion system for maneuverability in limited space. Water can be pumped through openings in the ship's hull at both bow and stern, below the waterline, to produce jets capable of moving the 40,000-ton liner sideways.

• • •

Interior decorators will rejoice over the news that fire hose by Goodyear now comes in red and yellow, as well as black and white. Or, it can be custom-colored. Advantages of colors over white—besides their decorative value—are that red is easy to spot, yellow is good for use in poorly lighted areas, and black "won't show dirt" in locations where dark discoloring materials are present. The hose is made with a Dacron jacket impregnated with Neoprene rubber for resistance to oil and chemical discoloration.

• • •

No need to give up your pool for the winter, even if it is outdoors. A clear plastic enclosure, made of Union Carbide's Krene flexible vinyl sheeting, was developed by the Plastimayd Corp. of Portland, Ore., to extend the season for outdoor swimming pools. This Space-Arena is held in place by water tubes constructed in its base and/or sand bags. A 1/10-hp blower inflates the enclosure and supports it. Air is changed continuously, and heat is provided by the sun, supplemented by a small electric heater if necessary.

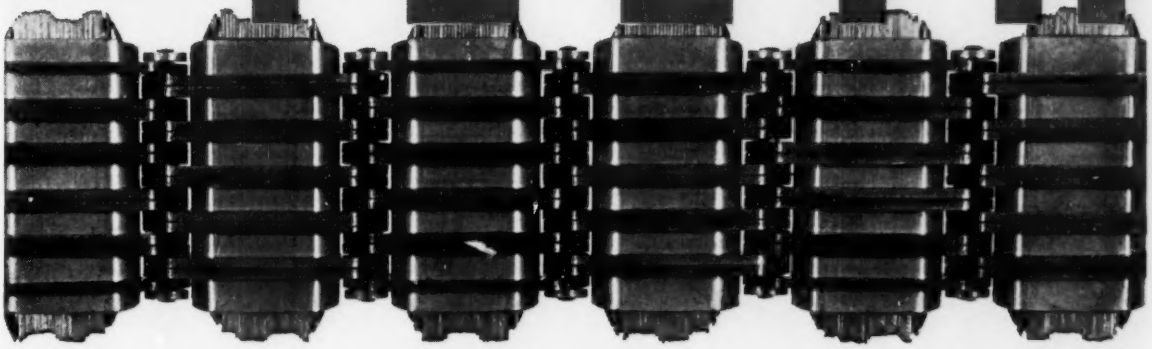
• • •

Plastic will also defy winter by helping to keep ice off sidewalks of the Eastwood Shopping Center, now being built near Pittsburgh. Chromalox Thermwire, made by Edwin L. Weigand Co., is being imbedded in Eastwood's walks; Goodrich Chemical's Geon 880 vinyl insulates the heating wire and protects it from abrasion and corrosion.

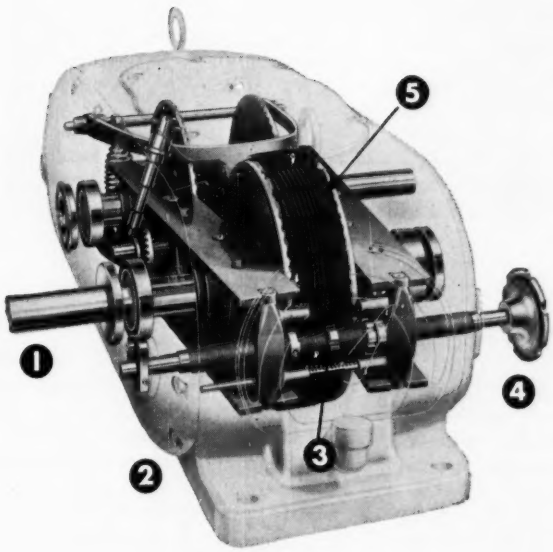
• • •

Do-it-yourself retreads, made in Italy, will come to U. S. markets in the spring. Tread for this new type of tire consists of three solid-rubber rings lined with metal mesh; the rings fit side-by-side on a special casing. Replacing or changing tread is done by deflating the casing, slipping off one set of rubber rings, and slipping on another set. Tread rings are held in place by radial ridges on the casing and by pressure of the air inside. Pirelli, S.P.A., the manufacturer, says that casings can give double or triple mileage with replaceable treads.

PUT TEETH



IN YOUR SPEED CHANGING JOBS



Get the positive, accurate control that only LINK-BELT's chain-driven P.I.V. can deliver

Yes, you put teeth into your speed changing jobs because Link-Belt P.I.V.—unlike other variable speed drives—utilizes an exclusive metal, self-tooth-forming chain.

Here's how it works! P.I.V. chain consists of a series of overlapping steel links. The links contain packs of slats which are free to move from side to side, singly or collectively, to serve as teeth. The chain meshes with radially grooved wheels, which are cut to a constant depth towards the wheel periphery. Beveled sides of the grooves offer gripping areas . . . provide a positive, nonslip contact at any speed, under all loads.

Makes changing speed simple too! A turn of the control screw simultaneously varies the effective diameters of the conically shaped wheels—closing one set, spreading the other. At the same time, the self-tooth-forming chain automatically adjusts to provide desired ratio between the input and output shafts.

BOOK 2274—Your Link-Belt office has Book 2274 on P.I.V. drives from ½ to 25 hp. Refer to the yellow pages of your local phone directory under Power Transmission Equipment.

(1) You can get minute speed changes and maintain them accurately while operating under full load.

(2) All-metal, totally enclosed—unaffected by atmospheric conditions. All vital operating parts splash-lubricated from a common housing reservoir.

(3) Easy-view speed indicator facilitates speed selection and adjustments to meet all requirements.

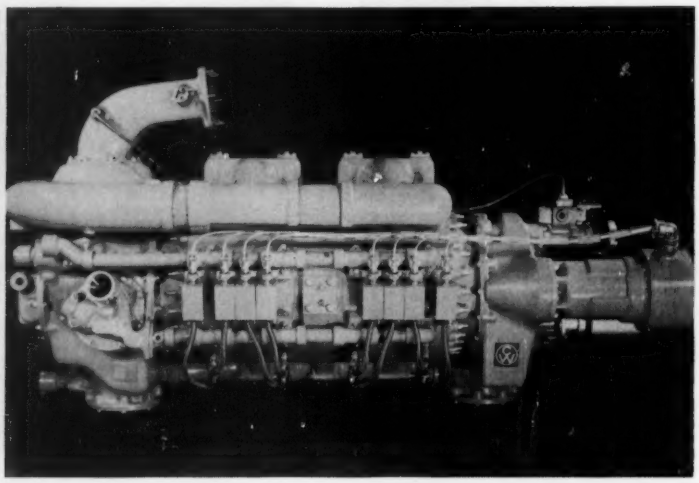
(4) An infinite number of positive, stepless speed adjustments may be made with manual, electric, pneumatic or hydraulic controls.

(5) Self-tooth-forming chain is made from a series of overlapping steel links. Links contain packs of hardened steel laminations or slats (shown above). Slats grip toothed wheels positively without slippage—give the speed you need at any setting.

15.242

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To serve Industry There Are Link-Belt Plants, Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World.

LINK-BELT P.I.V. VARIABLE SPEED DRIVE



Radical New Engine Claimed by Curtiss-Wright

An internal combustion engine with two moving parts, a power-to-weight ratio of 2 to 1, and specific fuel consumption of 0.45—all surrounded by a considerable amount of secrecy—may be on the market next year. Curtiss-Wright Corp., who developed the unique powerplant jointly with NSU Werke, West Germany, describes the machine as a "rotating combustion" engine working on the trochoid principle: A three-lobed rotor ("nutating" in a four-sided chamber) and a crankshaft are the two moving members. Fuel for the engine is regular gasoline, mixed with air by an automotive-type carburetor. The mixture enters the four-sided engine chamber through a sidewall port; as the rotor turns, rotor lobes "corner" and compress the mixture sequentially. After each firing (by a single spark plug), exhaust gas exits through a second port. There are "three power sequences per revolution of the crankshaft, maintaining an almost continuous intake, compression, ignition, expansion, and exhaust cycle," according to Curtiss-Wright spokesmen. A 100-hp unit (left), made largely of cast iron, weighs 100 lb. Future aluminum versions will weigh half as much. A 600-hp model (right) is being developed for aircraft use. Some sources say that CW's engine is similar in operation to lobed pumps—in which case the critical (and sometimes impossible) factor has always been end sealing of the lobed rotor and line sealing between rotor and combustion chamber.

Air-Hardening Nickel Steels Hit 290,000 psi

New Alloys Cold Form Easily, Can Be Welded Without Preheat

NEW YORK—Air-hardening nickel-alloy steels with yield strengths of 290,000 psi, 6 to 10 per cent elongation, and hardness in the neighborhood of 67 Rockwell C are on their way to market. Members of the new alloy family, invented by C. G. Bieber, Research Metallurgist at International Nickel Co., also possess excellent cold-forming characteristics after a simple annealing treatment which consists merely of air cooling from solution temperature. In this condition, they have a yield strength similar to that of mild steel.

The fact that the high-strength properties are obtained without liquid quenching means, of course, that intricate parts can be fabricated to close tolerances while the steel is in its soft annealed condition and can be hardened to the high-strength levels without appreciable distortion. This, plus superior mechanical properties, makes the 25 per cent nickel steels well suited for aircraft and missile applications and for high-strength, wear-resisting precision parts, such as bearings.

Another unusual feature of the new steels—they are weldable in the hardened condition without preheat. This, added to high strength (which is not limited to thin sections), makes them attractive for use in heavy-wall pressure vessels. Readily hot worked, the alloys can be produced in all the various commercial shapes—bars, plate, sheet, tubing, etc. While not yet commercially available, it is expected that they will soon be produced by a number of steel companies.

Patent applications indicate that the steels are responsive to both precipitation and martensitic hardening. Using a combination of these methods, properties are controllable over a broad range.

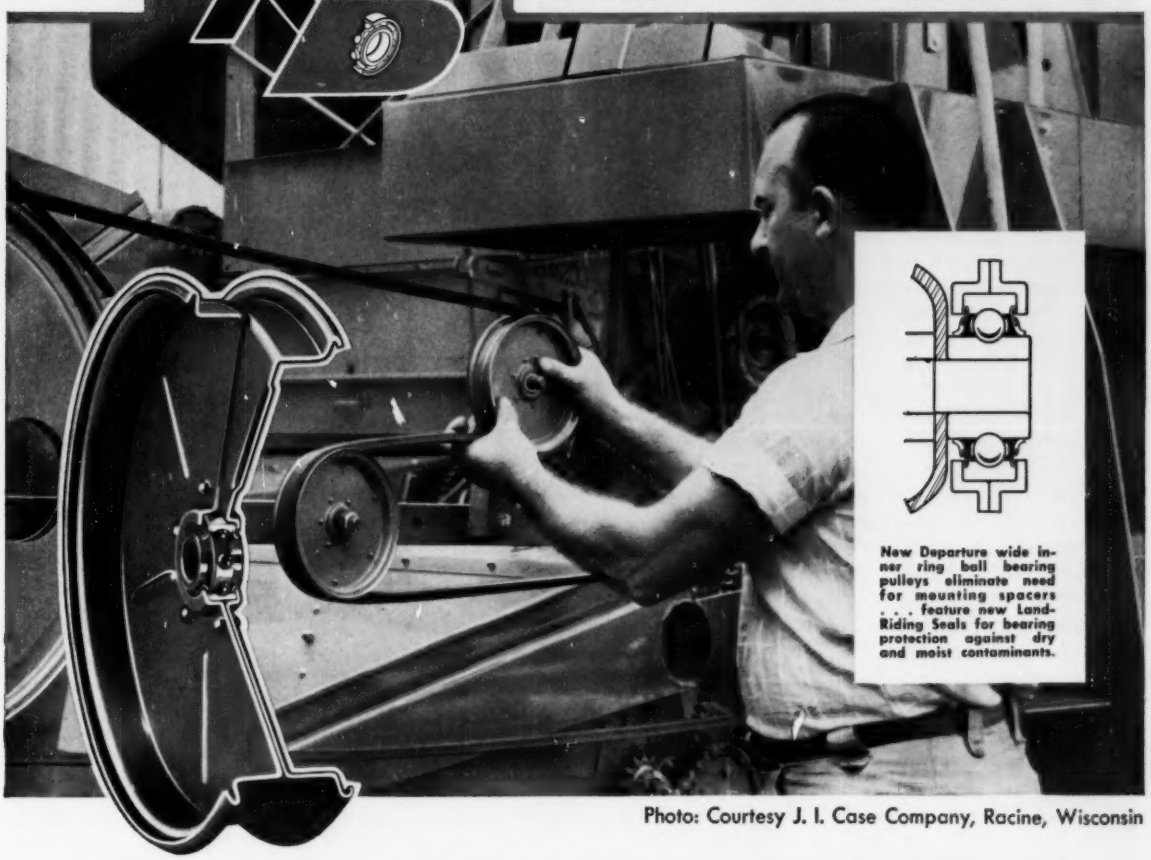
U of M Engineering Seniors Getting More Job Offers

ANN ARBOR, MICH.—The number of jobs offered to University of Michigan engineering students is up from last year, reports Assistant Prof. John G. Young, placement director for the Engineering College. Demand is primarily for "quality men for research and development work," both in commercial and defense fields.

Last year, 47 per cent of the positions accepted by U-M graduating engineers were in R and D work. Another 27 per cent entered design fields, and 10 per cent went into training programs.

Contrasted to the increased recruiting activity this year is a decrease in the students' desire to be interviewed. "They are not interviewing as actively as last fall," Professor Young explains. "I think this is because they realize the lush job situation, unlike last fall when they had the recession freshly in mind."

CASE HISTORIES



New Departure wide inner ring ball bearing pulleys eliminate need for mounting spacers . . . feature new Land-Riding Seals for bearing protection against dry and moist contaminants.

Photo: Courtesy J. I. Case Company, Racine, Wisconsin

Idler Pulley Assemblies Help Combine Manufacturer Cut Inventory & Assembly Costs!

CUSTOMER PROBLEM:
Leading farm implement manufacturer experiencing rising costs in the installation of ball bearing pulleys on combines and other farm implements.

SOLUTION:
N/D Sales Engineer, in cooperation with the manufacturer, made an evaluation of pulley applications. He then recommended N/D Land-Riding Seal pulley assemblies containing ball bearings with *wide* inner rings. The wide inner ring paved the way to cutting costs by eliminating conventional spacer inventories. Moreover, the manufacturer now enjoys additional savings because N/D Lubricated-for-Life ball bearing pulleys are *fully assembled* at delivery . . . simplifying inventory even more!

The wide inner ring bearing, butt mounted rigidly against face plate, requires a minimum of parts handling and adjusting at assembly. In addition, these 8" O.D. pulleys have rolled sheave edges for belt protection. All pulleys come with the new and exclusive N/D Land-Riding Seals, factory greased, ready to offer full maintenance-free protection against dry and moist contaminants.

If *you're* a user of flat and "B" section V-Belt pulleys, sizes from 2¾" to 8" O.D., why not check on the savings N/D has to offer? Contact your local N/D Sales Engineer or, write today for the new N/D Idler Pulley Bulletin giving complete specifications and mounting data. New Departure Division, General Motors Corp., Bristol, Conn.

Replacement pulleys available through United Motors System and its Authorized Bearing Distributors.

NEW DEPARTURE
BALL BEARINGS
proved reliability you can build around

High-Strength Alloy Steel Makes Debut in Navy Fighter

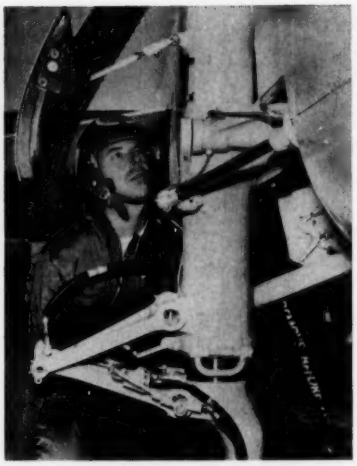
First Use in Main and Nose Landing-Gear Assemblies

YUMA, ARIZ.—A new supersteel is bidding for some of the roughest jobs the jet flight era has to offer. Known as "USS Strux," the alloy packs about seven per cent more strength per unit weight than other structural alloy steels now used for aircraft and missiles. Key parts can be heat treated to tensile strengths ranging from 280,000 to 300,000 psi.

First use for the new alloy, developed by United States Steel Corp., is in the landing gear of Navy's A3J Vigilante. Strux components in the main gear include the outer cylinder, inner cylinder (piston), fork, and trunnion. The nose gear uses a Strux inner cylinder and fork. (Sliding surfaces of the pistons are chrome plated.)

Landing-gear forgings made from the steel are among the most critical parts in the twin-jet craft. They must be light enough to insure superior flight performance, yet tough enough to withstand high-speed landings. U.S. Steel spokesmen feel it may now be only a short step from jet-plane landing-gear parts to the touchdown mechanism of a moon rocket. They point out that advances in the conquest of space are governed largely by the development of metals light enough to pay their way, yet strong enough to withstand the terrible punishment of launching, flight, and landing.

Despite the alloy's strength and toughness, it imposes no special manufacturing problems. It can be forged, machined, and heat treated by conventional methods. It is available either hot rolled or annealed in a full range of bar sizes and in blooms and billets up to 15¾-in. square.



First use of Strux is in key landing-gear parts for the Navy's newest supersonic attack aircraft, the A3J Vigilante. Each main landing gear must withstand loads of over 100,000 lb. Because the new steel boasts seven per cent more strength per unit weight than other alloys used for landing gear, the gear has the lightness needed, plus the toughness to withstand the crunching impact of high-speed landings on carrier decks.

Here's What Strux Will Do . . .

Under Static Load

Tempering Temperature (F)	Yield Strength (psi)	Tensile Strength (psi)	Elongation (per cent)	Reduction of Area (per cent)
450	242,860	291,300	10.25	37.5
550	243,390	281,100	10.75	38.2
650	233,260	265,220	10.25	39 6
750	216,420	239,070	10.75	39.7

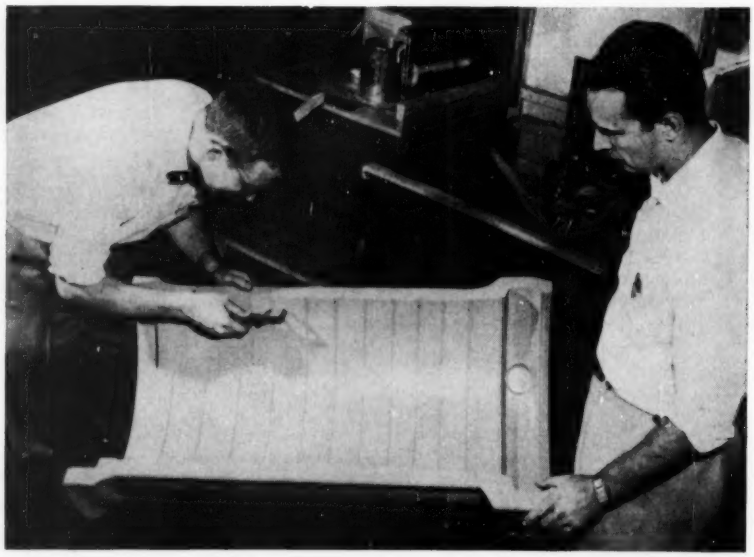
Under Dynamic Load

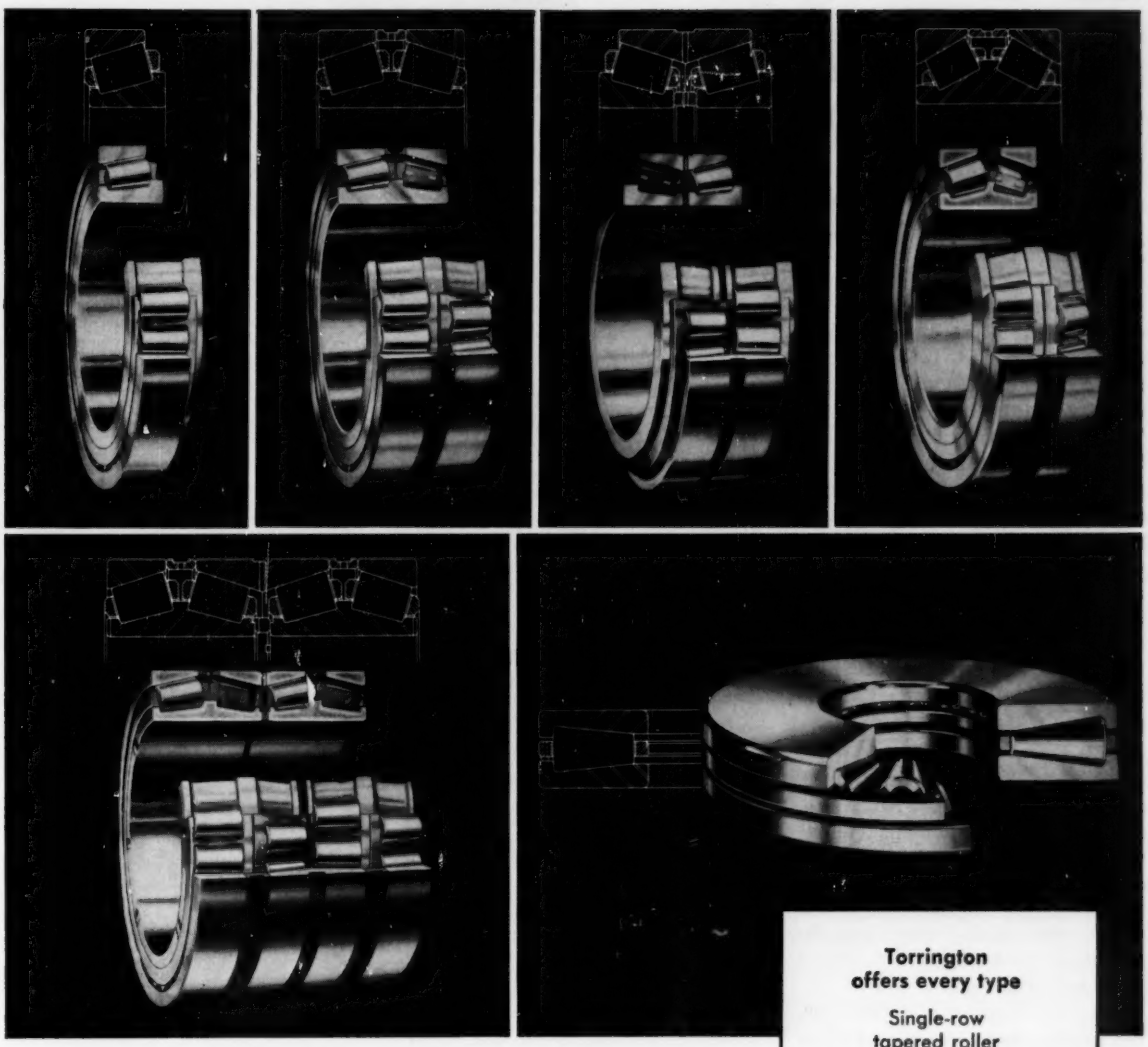
Stress (psi) Causing Failure After . . . 5000 Cycles	20,000 Cycles	100,000 Cycles	Infinite Cycles*
Test specimens unnotched			
225,000	190,000	160,000	125,000
Test specimens notched			
180,000	145,000	120,000	100,000

*Endurance Limit

Plastic Housing Proves Out For Jet-Engine Compressors

Reinforced-plastic compressor housings may soon replace aluminum and magnesium housings on jet aircraft engines. A polyester resin reinforced with glass cloth, developed by Westinghouse's Aviation Gas Turbine Div., does the job. The plastic housing has been tested for 150 hours—equivalent to 75,000 air miles—and is still in excellent condition, according to Westinghouse engineers. First large plastic component to resist all the rigors of full-scale engine operation, it offers the engine designer lighter weight, lower cost, more resistance to corrosion, and increased high-temperature strength (above 450 F) than now possible with metal housings. Westinghouse predicts the new housing will initiate widespread use of plastics in engines.





Torrington offers every type

Single-row tapered roller

•

Two-row tapered roller, solid cone

•

Two-row tapered roller, solid cup

•

Steep angle, two-row tapered roller

•

Four-row tapered roller

•

Conical roller thrust

•

Patterned for performance... Torrington Tapered Roller Bearings

Torrington Tapered Roller Bearings are made to virtually every design pattern for your particular performance requirements.

There are single-row, double-row... four-row tapered roller bearings—all in regular or steep angle design for radial and thrust loads—and conical roller thrust bearings for heavy thrust loads. Each is designed for dependable service in its operation.

Whether your application calls for a catalog bearing, or one custom-built to your specifications, you can rely on Torrington for utmost precision of manufacture, quality material, advanced metallurgy... and engineering experience based on the manufacture and application of every major type of anti-friction bearing. **The Torrington Company, South Bend 21, Ind.—and Torrington, Conn.**

TORRINGTON BEARINGS

Every Basic Type of Anti-friction Bearing

TAPERED ROLLER • SPHERICAL ROLLER • CYLINDRICAL ROLLER • NEEDLE • BALL • NEEDLE ROLLERS • THRUST

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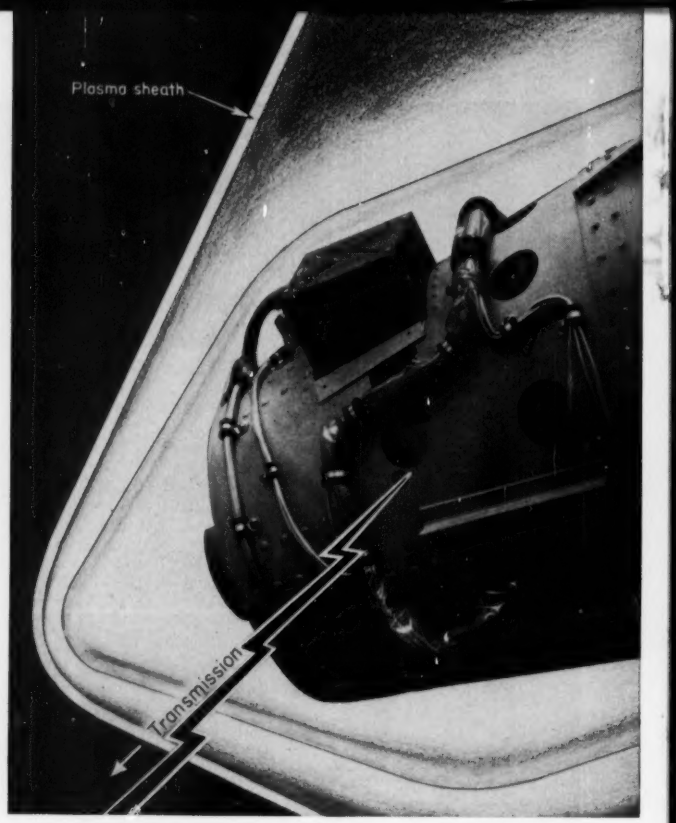
Re-entry Recorder Foils Plasma-Sheath Blackout

Stores Nose-Cone Data, Plays Back When Heat's Off

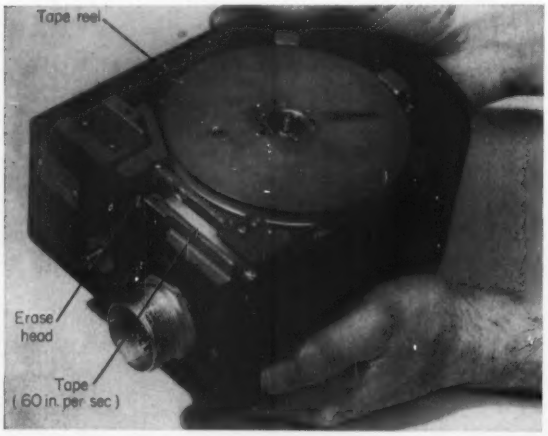
BALLISTIC-ROCKET trackers on the Atlantic Missile Range—monitoring telemetry outpourings from high-flying nose cones—know that a sudden radio blackout doesn't necessarily mean electronic-equipment failure. When the "bird is green" (a perfect launch), the interruption often signals the onset of the violent re-entry flight stage. This is when the radio-opaque "plasma sheath" forms around the nose cone, surrounding it with a shell of hot, ionized air that blocks transmission of vital temperature, stress, and deceleration data. To preserve such re-entry information, missiles like Thor-Able now carry a rugged little tape recorder that occupies less than one-fifth of a cubic foot in the crowded instrument capsule. Designed and built by Ampex Corp., Redwood City, Calif., the recorder stores nose-cone performance data during the telemetry transmission blackout, plays back its record to ground stations during slower, cooler stages of the nose cone's final plunge.

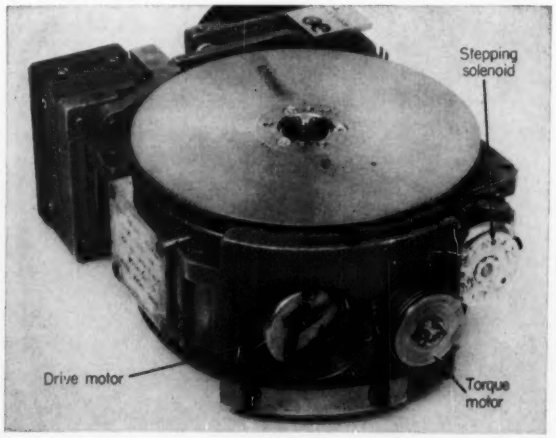


Playback of data from the recorder to missile-range telemetry receivers is either automatic (in reverse after a 5-sec delay), or it can be triggered by a radioed command signal. Information on the 4-min, two-channel tape may be reproduced and transmitted several times before the plastic sphere containing the recorder is ejected from the nose cone, usually several thousand feet above the ocean.

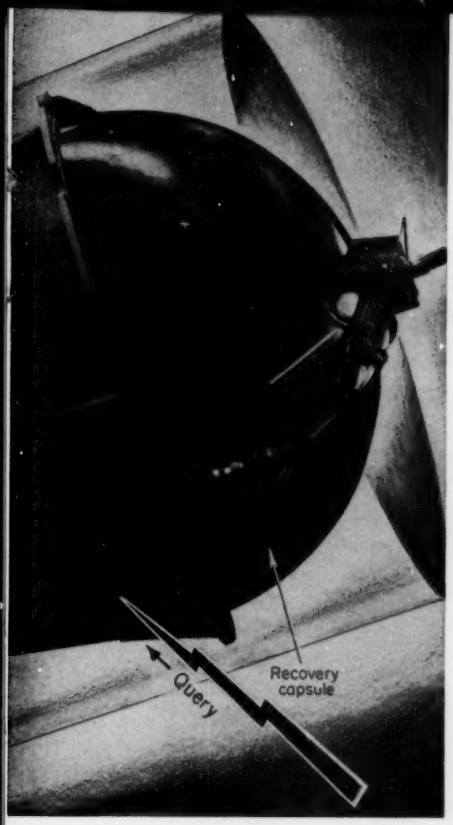
The light sphere falls free at a rate slower than the cone itself, but still fast enough to require an ablative protective shell. This cover shatters when the sphere hits the surface of the sea, an impact that can produce decelerations as high as 40,000 g's.

Normally, the tiny tape recorder isn't expected to emerge unscathed after such a violent dunking. The design goal is considered met if the tape is recovered intact and the recorder is totally destroyed. However, Ampex is proud of a unit that recently performed within specifications (tape and turntable were replaced) after impact with the sea, 9 days immersion in salt water, and exposure to electrolyte from a ruptured instrumentation battery. Recovery of the sphere is usually more prompt: Dye markers aid visual search; a salt-water activated battery puts a radio transmitter on the air and detonates a "sofar" bomb, giving a fix to search ships.

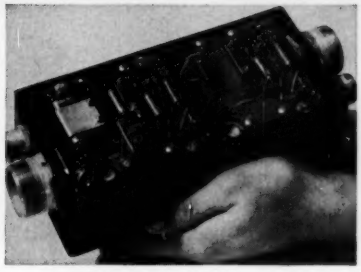




Weighing only 20 lb (including separate record and reproduce amplifiers), Ampex's MR-100 recorder captures information in the 300 to 100,000-cps band. Low-inertia tape reels, accommodating 1400 ft of tape, permit 2-sec starts on the basic 60-ips tape speed. Tape-transport components, mounted on a cast-aluminum chassis, withstand shocks up to 15 g and acceleration forces up to 75 g. The heavy case doubles as armor to protect the tape during impact. Ampex decided to use no lubrication in the recorder, found dry gears exceeded 100-hr life requirement.



Recovered information capsule (designed by General Electric) is chiseled open on the deck of a picket ship. Strong enough to protect the vital tape on impact, the urethane-foam sphere is light enough to float in the water.



Etched circuit boards in the amplifier-oscillator package are coated with a silicone-base fluid to stop component shifting under vibration and shock. Components can be replaced since the compound doesn't harden completely.

DRAFTING TRENDS

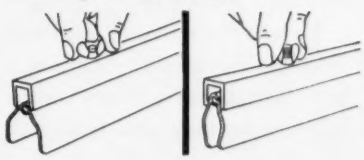
This Rolling Stand is one of many new Plan Hold units recently developed to make vertical filing more efficient.

New efficiency in vertical filing equipment

Vertical filing is a real space-saver, but home-made or "Rube Goldberg" systems have always created problems. Holes must be punched or drilled in blueprints and maps. Unsightly supports and devices must be built to hold groups of drawings and plans. None of these methods have ever been entirely satisfactory.

Now, with any one of the dozen modern Plan Hold Vertical Filing units, these problems can be eliminated.

Spring-actuated binder holds up to 100 sheets



The keystone of all Plan Hold units is the individual binder. It holds one to 100 prints safely and securely. The spring-actuated clamp is controlled by wing nuts to open and close the binder. The sheets hang wrinkle-free without curling. Binders are available for all popular sheet sizes.

Space-saving units provide maximum flexibility

The trend toward vertical filing is growing rapidly because of the flexibility offered. Plan Hold units can be installed anywhere . . . on the wall, at a table, in cabinets, closets, vaults or in rollaway units. Even hard-to-file items can be accommodated in special vertical pocket files.

The range of Plan Hold units that can handle various vertical filing situations includes space-saving wall racks, carousel-type units, rolling stands, swing-away racks and complete cabinets. They protect drawings, eliminate folding, rolling and stacking. And they provide an orderly, efficient system to accommodate and identify all large drawings.

For a complete 16 page catalog showing the full range of Plan Hold vertical filing equipment, write Frederick Post Company, 3652 N. Avondale, Chicago, Illinois.

POST

SENSITIZED PAPERS & CLOTHS • TRACING & DRAWING MEDIUMS • DRAWING INSTRUMENTS & SLIDE RULES
ENGINEERING EQUIPMENT & DRAFTING SUPPLIES • FIELD EQUIPMENT & DRAFTING FURNITURE

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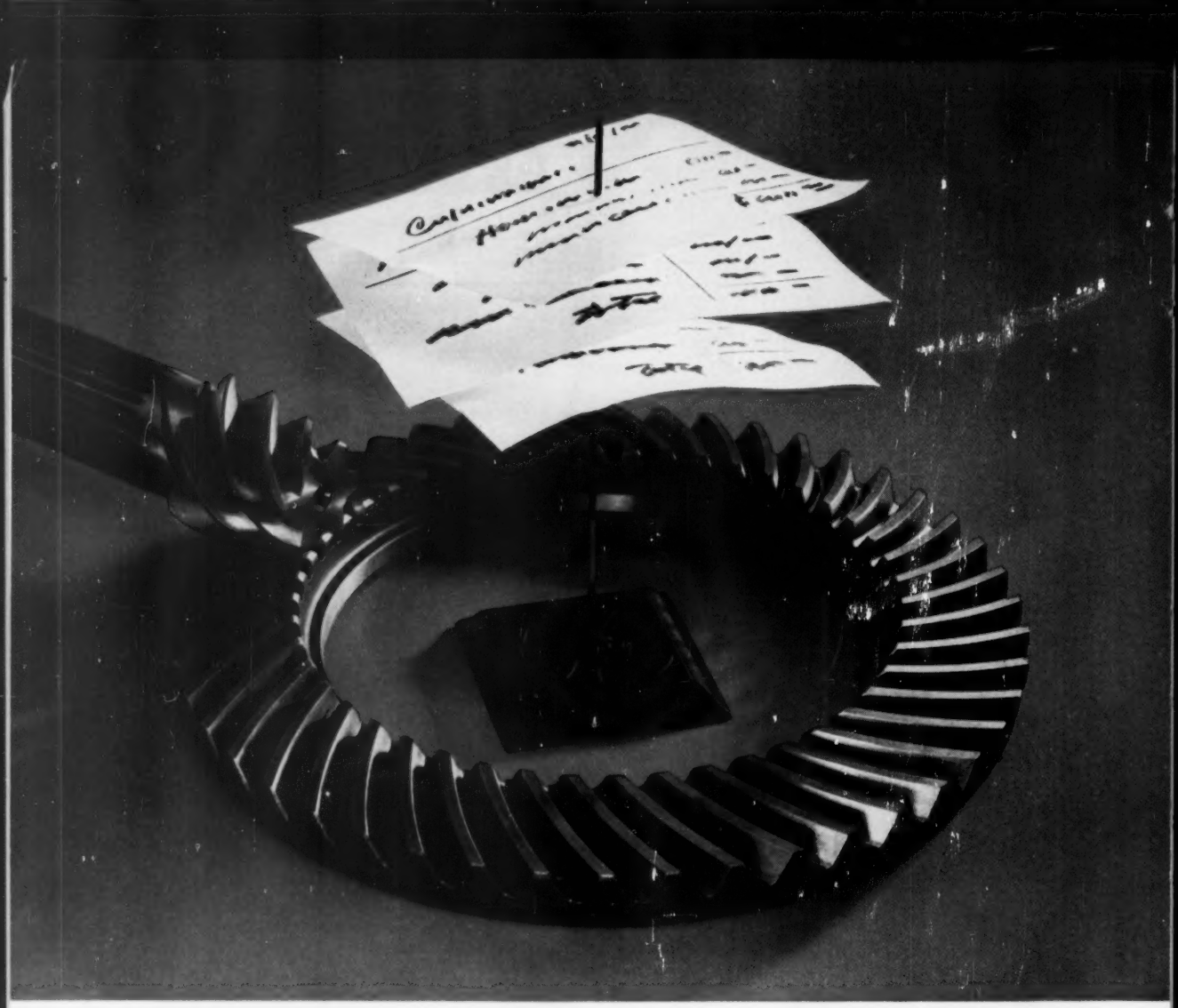

GEAR BILLS come in "THREES"

No matter where you buy them, every gear order automatically involves three costs.

1. *The initial cost of the gears themselves*
2. *The cost of installation*
3. *The cost of service*

The second two bills—installation and service—can run much higher than the initial purchase price. That is particularly apt to be true where corners are cut to make the purchase price low.

We always strive to produce "Double Diamond" Gears at a low initial price. Even more important, they are made to standards which lower the *total* gear cost—purchase price *plus* installation *plus* service. It is *that* figure that interests us most. If it interests you, too, you may find it worth your while to consult a "Double Diamond" engineer next time you're wanting gears of the many types we make.

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RICHMOND, INDIANA

GEARS FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS
GEAR-MAKERS TO LEADING MANUFACTURERS

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New materials prove ideal in handling temperature extremes −350° F. to +750° F.

Working with two remarkably versatile elastomers, C/R Sirvene engineers are producing flexible molded parts for many vital fuel, lubricating, hydraulic and pneumatic systems. One, Viton-A*, can be compounded to produce parts that function dependably at 600° F., and for short periods up to 750° F. The other important feature of Viton compounds is their excellent resistance to corrosive chemicals, chlorinated solvents as well as both synthetic and petroleum base fuels and lubes. At the other extreme, C/R compounded Silastic LS-53** parts are providing low temperature operation down to -80° F. They also exhibit excellent resistance to synthetic and petroleum base fluids up to 350° F., and function well in propane up to 500° F. For temperatures as low as -350° F., C/R recommends Teflon* compounds.

C/R Sirvene engineers have an intimate knowledge of these elastomers. They also have perfected special techniques in processing which still further improve the physical properties of the molded parts. If your problem involves high or low temperatures, close tolerances, and compatibility in advanced design fuel, lubricant or hydraulic systems, get in touch with us at once. We have the skill and the facilities to help you.

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C/R

Circle 413 on Page 19

"hot" hydraulics—progress and problems

The question—"Can hydraulics do the job above 1000 F?"—now rates the conditional, but encouraging, answer: "Yes, but not yet." This opinion came from Republic Aviation's Bill Mayhew, outlining progress in high-temperature hydraulics for participants at Vickers' Aircraft Hydraulics Conference. Most promising fluid to date, according to Mayhew, is polyphenyl ether (it has held for 9 hr at 1000 F). Major problem components are still seals, servo valves, pumps, and actuators. Although elastomers have shown "unexpected" durability at 600 F, metallic seals (perhaps in two-stage form) are probably inevitable for higher temperature and pressure ranges. The Republic group, working on Phase II of an Air Force program, is scheduling tests on a full-system mockup early in 1960.

no stackups for superjets

Navigational equipment that will guide a Mach-3 airliner 5000 miles or more and put it right at the end of the runway (at precisely the right time) is perhaps one of the most critical needs in the future of commercial aviation. One reason: Today's jet liners often reach a transcontinental destination with a two-hour fuel reserve—necessary in event of diversion or delay. A supersonic transport of the future, like Marquardt's ramjet (above) would, ideally, carry only a 15-minute reserve. Precise navigation would be the only salvation. For another reason: Air traffic controllers are bracing themselves to handle 1000 aircraft simultaneously during the 1970's: R. F. Miller, one of Northrop Corp.'s chief engineers, suggests immediate consideration of inertial guidance systems to solve the problem. He points out that most of the development work has already been subsidized by the military, and systems suitable for commercial application could soon be available.

tv by the numbers

Practical digital television developed by Colorado Research Corp., Denver, offers new "eyes" for deep-space probes. It may also have significant commercial applications. The transmitter in the new system sends simple "on-off" signals, which can be recognized at the receiver even when background electronic noise is exceptionally high. Once recognized, the signals can be "cleaned up" and rebroadcast in their original fidelity. The system seems especially suitable for space vehicles because intelligible signals can be sent long distances from small transmitters. Other jobs for digital TV: UHF broadcasting for home consumption may be greatly improved by the extended range and clean signals; program recording can be simplified because the signals are like those fed into a digital computer, i.e., they can be treated, clipped of redundancy and stored on magnetic tape.

heat to electricity: ferroelectrics next?

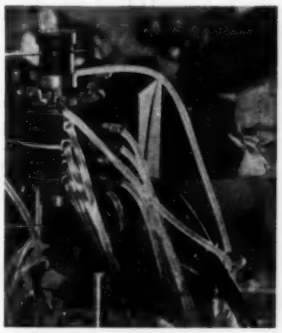
Now that thermionics has reached the commercial hardware stage, another exotic power source appears in the wings. Scientists at International Telephone & Telegraph Corp. have developed a dime-sized unit called a ferroelectric converter that also produces electricity directly from heat. Single ferroelectric elements have an output of more than 1000 v—and this is just the beginning. By arranging the remarkable wafers in series, IT&T hopes to perfect a truly miniaturized power source with a 1 million-v output.

irradiated insulation—nuclear Navy problem

A forthcoming atomic-era problem for designers—effects of nuclear radiation on wire insulation—is the subject of a concentrated research program now in progress at Naval Research Laboratory. Navy expects to develop "concepts, methods, and instrumentation for evaluating representative types of insulation," and will turn the resulting information over to various technical societies for preparation and dissemination of a radiation-insulation index.

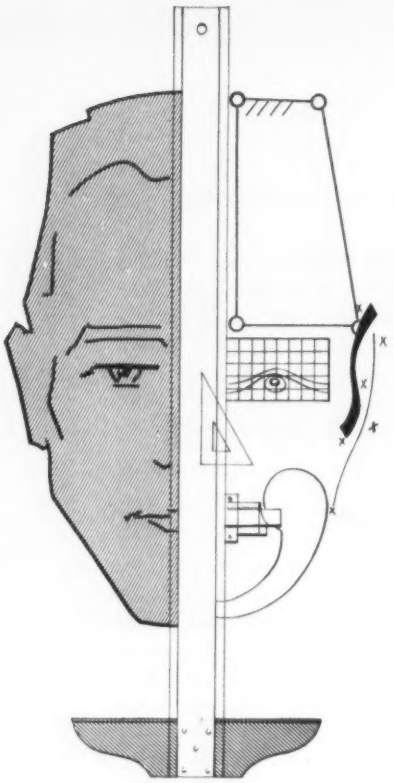
NBS works on high temperature standards

Reliable methods of producing and measuring temperatures up to 20,000 K are sought in new National Bureau of Standards research. The Bureau hopes the work will eventually lead to established high-temperature standards. Researchers are using an electric-arc furnace to measure current-carrying capacity of gas between the electrodes and, by this means, to calculate gas temperatures. Present research is concerned mainly with comparisons between photoelectric and photographic measurement methods, effects of optical geometry, arc length, and other high-temperature instrumentation problems.



gas-magnetic power sources

Impressive progress in magnetohydrodynamics has been reported by two leading companies during the past month. General Electric Co. and Avco Corp. both have MHD generators in lab form capable of producing significant quantities of electricity. General Electric thinks its version could be ready for space applications in a relatively short time, but hedges on predicting any immediate MHD applications in stationary power generation. AVCO, on the other hand, has already lined up ten utilities to help defer the cost of further research and predicts that MHD might be ready in ten years. Big selling point for MHD: It effects a 25 per cent increase in operational efficiency over conventional turbo-electric equipment.



EUGENE RAUDSEPP
Research Consultant
Deutsch & Shea Inc.
New York

Psychologists are intrigued by the engineer. Their tests show he's only moderately imaginative . . . tactless . . . impersonal . . . yet he teams with co-workers to create machines that make the world go around. Here's the picture psychologists paint . . .

The Engineer— *Paragon or Paradox?*

Part 1—His Personality

WHAT's in a norm? Psychologists, who delight in building a "typical" specimen, find engineers a predictable lot . . . a homogeneous group demonstrating a narrow range of temperaments and the same personality traits. It's impossible, they say, to find such consistency in other professional groups.

No one engineer, obviously, will conform to the group norm; he will be close in some areas, vastly different in others. But the group "profile"—as revealed by more than 150 studies correlated by the author—is clear. The over-all agreement is remarkable, especially since different psychological methods and techniques were employed.

This article, the first of three, paints a picture of the personality of the "typical" engineer. Articles that follow will fit together what's known about his intelligence, abilities, and interests.

Work Approach: Precise and Head-On

Most engineers are strongly work-oriented, serious-minded, and conscientious. In their work, they are precise and meticulous—almost perfectionistic—in attention to detail. They have high energy levels and they pour far more energy into work than do many people in other professions. This energy is directed to specific and attainable ends, for engineers find great satisfaction in tangible, concrete, and productive activity.

The engineer is able to stay with his work over long periods of time. He responds to pressure with increased exertion. When faced with problems, he tackles them head-on with a practical, direct-action approach—an approach with emphasis put squarely on the facts, rather than on abstract, intellectual, or intangible possibilities.

Tolerance for the Abstract—Low

The typical engineer shows disinterest in intangible affairs and unlimited theoretical problems. He is a practical man with his feet planted firmly on the ground. Hence, his strong tendency to limit his attention to immediate matters: He tends not to think far beyond the next step.

But this truncated perspective does not mean he is not stimulated by complex problems. On the contrary, he brings to bear considerable ingenuity and resourcefulness in working out new processes, applications, and techniques. However, he prefers to have a tangible assignment—an immediate goal, or a "cookbook" problem where steps to the solution are direct and uncomplicated. The danger in this approach, is that his sense of immediacy and concrete-mindedness blinds him to larger problems requiring creative leaps into the unknown. Nevertheless, this "here-now" view of his work enables him to get great personal satisfaction out of his daily assignments and achievements.

Resents Supervision, Respects Authority

The typical successful engineer maintains an independent, self-directing attitude toward his work. He accepts demands of the job and the company in a realistic way, but he resents tight controls and feels comfortable only when he is given little supervision.

In spite of his resentment, he has a positive attitude toward authority: He believes his superiors are competent and worthy of respect. The typical engineer does not easily forget authority in his relations either up or down the line. While he

Are You "Typical"?

This article gives some idea of the psychologists' "norm" for engineers, but how do you rate yourself? Check off the boxes (preferably before reading the article) and compare with the table on Page 28. If you want to blow off steam, send us your answers. We'll compile them and, in a later issue, show you a composite of what MACHINE DESIGN readers think of themselves.

How do you stand on:

	Very low	Low	Moderate	High	Very high
Diplomacy	☐	☐	☐	☐	☐
Cautiousness	☐	☐	☐	☐	☐
Work enthusiasm	☐	☐	☐	☐	☐
Introspectiveness	☐	☐	☐	☐	☐
Conformity	☐	☐	☐	☐	☐
Self-confidence	☐	☐	☐	☐	☐
Sensitivity to people	☐	☐	☐	☐	☐
Tolerance for intangibles	☐	☐	☐	☐	☐
Perfectionism	☐	☐	☐	☐	☐
Persuasiveness	☐	☐	☐	☐	☐
Professional ambition	☐	☐	☐	☐	☐
Communication skills	☐	☐	☐	☐	☐
Ingenuity	☐	☐	☐	☐	☐
Tact	☐	☐	☐	☐	☐
Ability under pressure	☐	☐	☐	☐	☐
Synthesizing ability	☐	☐	☐	☐	☐
Imagination	☐	☐	☐	☐	☐
Decision-making ability	☐	☐	☐	☐	☐

looks up to his superiors, he also expects to be looked up to in turn. He relies rather heavily on authority for settling issues.

Social Attitude: Casual, Impersonal

The typical engineer is formal, impersonal, reserved, self-sufficient, and independent. He has little interest in people. Preoccupied with the physical universe and the manipulation of things, he prefers to withdraw from the social world to the world of objects and ideas. Consequently, he is not gregarious or good at friendly give-and-take. He enters into few warm, close, friendly relationships with people.

The technical man has little analytic interest in motives and values of people. He avoids introspection and self-confrontation. Consequently, his insights, even in the direction of his own motives and attitudes, are shallow. Self-understanding, like awareness and understanding of others, is almost totally lacking. He finds difficulty in participating in activities with other people. He is not talkative and deals with others in a direct, matter-of-fact manner; his relations with his colleagues are casual, impersonal, and superficially friendly. He is not a good diplomat and often lacks communication skills. Emotional restraint characterizes all his dealings with others, for he is secretive about his feelings and often quite shy. He does not like to assume leadership in group activities, is vocally restrained and has inhibited social address. Harrison, Tomblen, and Jackson (in "Profile of the Mechanical Engineer") say:

• Interpersonal relations are harmonious but casual. Impersonality is one of their more common traits. An analytical interest in people is rare. They avoid introspection and self-examination. Insight is often shallow. Their lack of self-understanding makes them less perceptive to social manners and relatively insensitive to the less obvious needs of others. Engineers are straightforward, direct, and self-sufficient. They are inclined to be matter-of-fact and, outside their own field are often unimaginative. Their attitudes are realistic, though their brand of realism deals more with surfaces than with depths. When faced with problems they are advocates of the direct action approach. Polite diplomacy and oblique conciliatory tactics are foreign to their nature. It is not true that engineers are usually introverts. What sometimes makes them appear so is characteristic impersonality.

Major Fears: Criticism, Failure

Frequently the engineer appears overly critical and authoritative. This stems from his enormous need to "be right" and his sensitivity to criticism. His self-esteem and pride hinge on his ability to avoid criticism. Consequently, as a defense mechanism, he sometimes criticizes others before they do it to him.

Equally as much as he fears criticism, he fears failure. This dread of failure and criticism, coupled with his aversion to intangible, ambiguous, broad-scope problems (remember, he prefers concrete, orderly, manageable mechanical tasks), often prevents him from coming up with new creative ideas that industry vitually needs. According to Moore and Levy:

• They are intolerant of failure, and tend to condemn people who 'allow' themselves to fail or be inadequate. It should be noted that just this disapproval of failure is often a contributing factor in their tension—the possibility of failure is an abhorrent, but still a real fact. . . Similarly, their 'ethical' behavior is sometimes built more on fear of censure than on comprehension of constructive values. . . On the positive side, they are, by and large, constructive in their influence on both social and business groups, and will undertake projects and responsibilities for the public welfare.

Intelligence: High But Specialized

Engineers, on the whole, are a very intelligent group, but they use

Engineer—Manager: Room for Improvement

"Because of his [the engineer's] confidence in dealing with mechanical principles, he tends to apply them to people, with inevitable failure in achieving a successful relationship with people. His understanding of physical laws, with their predictability, leads him to expect the same kind of predictability in people . . . If there is one kind of person which an engineer is most likely to render ineffective when he supervises, it is another engineer. The engineer's tendency to be critical, unappreciative, and exacting of others is most likely to sabotage the efforts of a person who, like himself, has this typical, brittle sensitivity to criticism."

—Dr. Charles E. Goshen: *The Engineering Personality*

"Engineering and technology are set up to get the job done. Men who enter this kind of work . . . are men who tend to emphasize (1) a clear definition of what the job is, (2) previously tested ways of doing it, and (3) a concrete outcome, to prove they've done it. . . Such men are uneasy with the psychological problems which are inescapable aspects of the management of the organization. These sorts of problems are often ill-defined, without clear answers from traditional practice, and not at all concrete. Engineers therefore tend to back away from leadership responsibilities in these matters, turning over this responsibility to anyone else who will take it."

—Prof. Ross L. Mooney, Ohio State University

"As an executive, the engineer usually retains the philosophy of his former science—chemistry, mechanics, whatever—and strives to design and control human activities as he did the physical processes formerly."

—Moore and Levy: *Artful Contrivers: A Study of Engineers*

their intelligence in a very specialized, narrow way. This leads to a lack of broadness in point of view. This became especially evident in their stories to the Thematic Apperception Test* as reported by Harrison, et al.:

• The stories of engineers are usually short and simple in structure. In a sense they are picture-bound, for they give descriptive material which is closely associated with the picture. . . Engineers appear to be concrete-minded; their approach is tactical rather than strategic. Though the stories are sharply drawn and compactly organized, one would be likely to underestimate the intelligence of the narrators. . . Their abilities do not show to the best advantage in these rather flat, unimaginative productions. . . A related finding is the matter-of-factness of the narrative. The content is commonplace, prosaic and usually lacking in dramatic values. While their 'stories' are not lacking in affect, there is a subnormal degree of emotional involvement or empathy with the fictional characters. . . There was an almost total absence of phantasy of inner life on the part of the characters. The stories were peopled by individuals who never introspect. Feelings were expressed but tended to be superficial and closely related to external events. The stories were concerned with surface actions and were lacking in depth. In contrast to a large number of overt problems and dilemmas, there was relatively little intrapsychic or psychodynamic material. The engineers' narratives contained less emotional conflict, anxiety, guilt, depression and inferiority feeling than do the stories of most college-educated subjects.

Over-all Adjustment: Reasonably Good

Goodman (in "A Comparison of the Interests and Personality Traits of Engineers and Liberal Arts Students") also found that engineering students are less neurotic and more self-sufficient than liberal-arts students. Other tests found engineers to be quite tense and unstable, exerting rigid control over their emotions.

An Allis-Chalmers study ("Scientific Selection of Engineering Personnel") found that design, manufacturing, and research - development engineers have an average general adjustment. On self-sufficiency, all groups, with the exception of design engineers, rated high. The latter rated average on this

*Subject being tested is shown a picture (everyday event, an accident in the home, etc.) and is told to make up a story about it.

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Here's how "Norm" Engineer measures up

—on the characteristics "tested" on Page 25

—on other (just as important) personality traits

Very high

Orderliness	Methodicalness
Sincerity	Honesty
Serious mindedness	Integrity

High

Impersonality	Industriousness
Acquisitiveness	Willingness to work
Emotion control	Persistence
Conscientiousness	Endurance
Determination	Interest
Dependability	Analytical ability
Drive	Organizing ability

Moderate

Resourcefulness	Shyness
Forcefulness	Open-mindedness
Independence	Tolerances for complexity
Patience	
Assertiveness	Good memory
Aggressiveness	Initiative

Low

Gregariousness	Self-consciousness
Talkativeness	Social intelligence
Poise	Adaptability
Sense of humor	Co-operativeness
Communication skills	Leadership ability

Very low

Impulsiveness	Haughtiness
Snobbishness	Vanity
Conceit	Indolence
Arrogance	Moodiness
Exhibitionism	

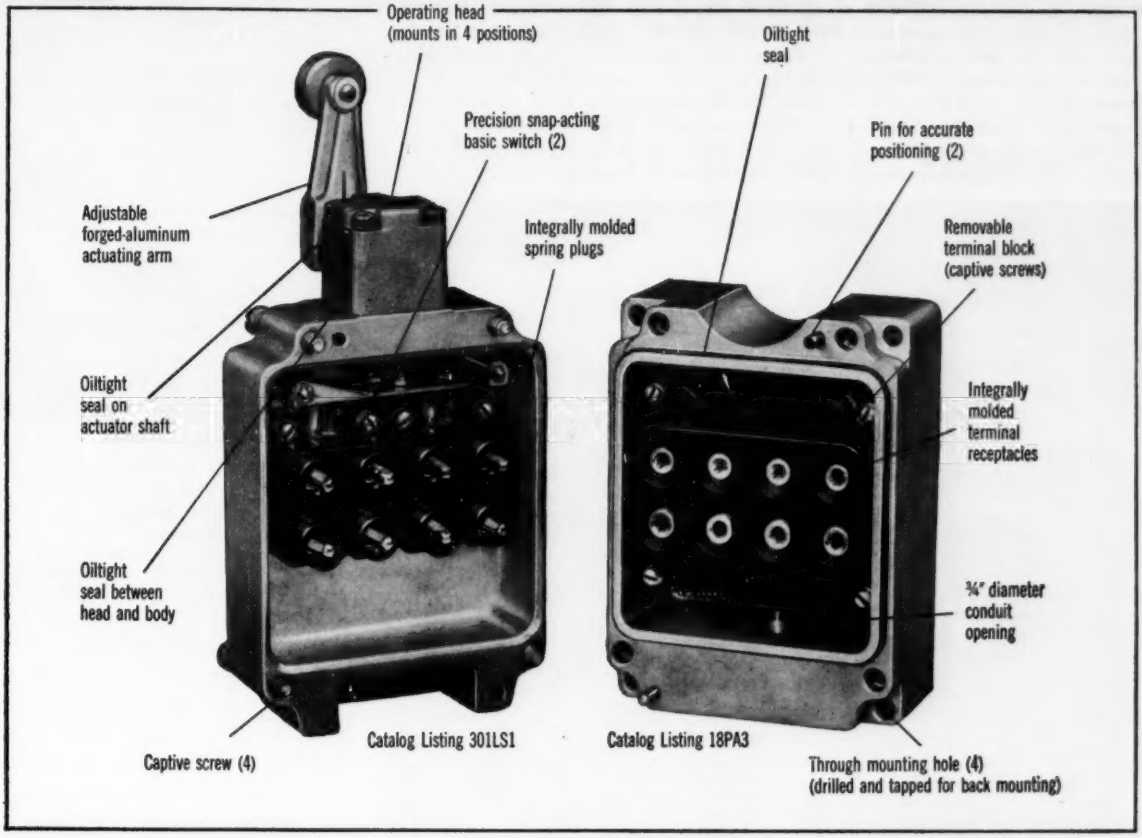
personality dimension. Social dominance was found high in sales and manufacturing, average in research-development engineers, and low in design engineers. All groups scored high on confidence. Sales engineers attained a high score on sociability, but design and research-development specialists scored low.

Summing up: Engineers are action-oriented, they like to get things done. They are orderly and well-organized both in their work and their life. Harrison, et al., put it this way:

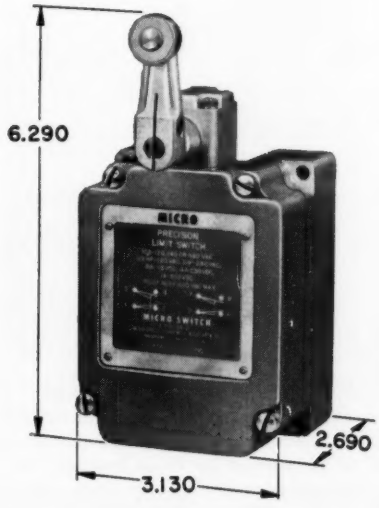
• Not only do they lead well-ordered lives but their attitudes and behavior lean heavily toward conservatism. . . Aside from more specialized knowledge and greater intellectual ability, the typical engineer in many ways suggests the stereotype of John Doe, conventional, solid citizen. . . Engineers conform socially and do what is expected of them, but there is reason to believe that for many of them, personal relations have less significance than they do for the rest of the population. They are concerned with human relations insofar as people are a necessary part of their operations, but they have little interest in people as such. . . Engineers seem to have less awareness of the importance of emotional life, of unconscious impulses, and of irrational elements in human conduct.

Second article in this series, in the December 24 issue of MACHINE DESIGN, will deal with intelligence and ability of the "norm" engineer.

"Think you'll like it here?"



This new Center Neutral "Plug-in Limit" Switch can perform the job of two separate limit switches



- **Contains 2 basic switches, controls 4 isolated circuits**
- **Plug-in design permits fast replacement**
- **Oiltight construction**
- **Completely adjustable actuating head**

MICRO SWITCH's newest "Plug-in Limit" switch contains two double-break precision, snap-action basic switches. The lever arm operates one basic switch when moved to the left, the other when moved to the right. Neither switch is operated when the lever is in the center position.

For further details, write or call the MICRO SWITCH branch office or authorized distributor near you. Consult the Yellow Pages. Ask for Data Sheet 168.

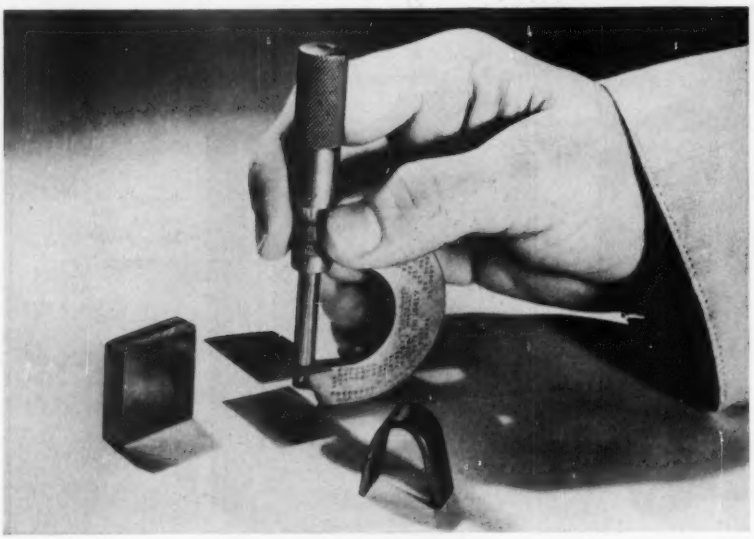
MICRO SWITCH ... FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls Limited, Toronto 17, Ontario

Honeywell
MICRO SWITCH Precision Switches

Circle 415 on Page 19

Heavier Than Lead (and Formable)

Weighty components can now be specified in a brand new material. Mallory 3000, a hefty alloy developed by P. R. Mallory Inc., Indianapolis, has almost half again the density of lead. It also excels in its class by being easily cold-worked and formed, doesn't have to be machined or molded to shape. Illustrated below: A 0.003 in.-thick sheet (center) and 0.07-in.-thick formed piece (right) cold rolled from the 0.33-in.-thick slab (left). For complex fabrications, the new heavyweight responds well to brazing and sinter welding. Typical applications: Weights, counterweights, and radiation shielding.



Physical Properties of a New Heavyweight Contender

Pressed and Sintered:	
Ultimate tensile (psi)	125,000
Proportional limit (psi)	56,800
Yield strength (psi)	86,800
Hardness (Rockwell C)	24
Modulus of elasticity (psi)	37.4×10^6
Modulus of rupture (psi)	314,800
Elongation (per cent/in.)	15
Density (gm/cc)	17
Thermal conductivity (CGS units)	0.18
Cold Rolled (52 per cent reduction)	
Ultimate tensile (psi)	195,000
Proportional limit (psi)	90,000
Yield strength (psi)	190,000
Modulus of elasticity (psi)	54×10^6
Elongation (per cent/in.)	0.5

Short-Time Tensile Strength At Elevated Temperature

Temperature (F)	Tensile Strength (psi)	Elongation (per cent)
1200	70,500	5
1500	55,000	3
1800	31,000	4.5
2000	19,350	5

"Reasonably" Pure New Alloy Makes Strong Aluminum Parts

Iron Impurities Countered By Beryllium Traces in Melt

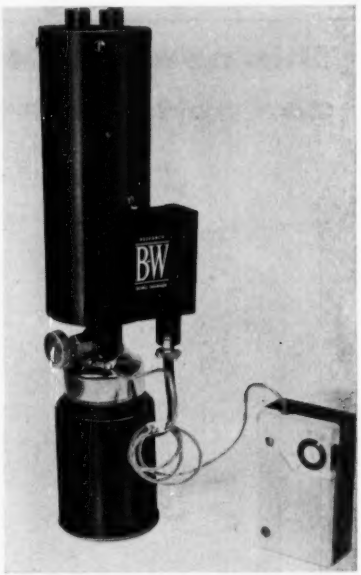
EL SEGUNDO, CALIF.—A new aluminum alloy can be cast to the high strengths necessary for missile parts. Developed and patented by North American Aviation Inc., it avoids the restrictions of the "high-purity" approach to high-strength aluminum castings.

Few foundries can afford the expensive procedures necessary to achieve acceptable castings from noncontaminated aluminum. The new alloy shows a way out, however, for it modifies iron impurities. Ordinarily, iron picked up during melting and pouring of aluminum embrittles the casting. NAA metallurgists found that adding a small amount of beryllium to the melt forms a beryllium-iron complex. The alloy's strength is unimpaired—in fact, parts can now be produced stronger, more economically, and easier than with conventional alloys.

The alloy — Tens-50—is finding so many volume uses in castings for liquid rocket engines that price decreases are already possible, says Pat Bales, general manager of NAA's invention-marketing subsidiary, Navan Products Inc. "Higher tensile strengths are possible with castings made from the Tens-50 alloy than from the high-purity metal. Superior foundries can use it for lower cost, high quality production, and many more average foundries are given capability to cast parts to acceptable standards."

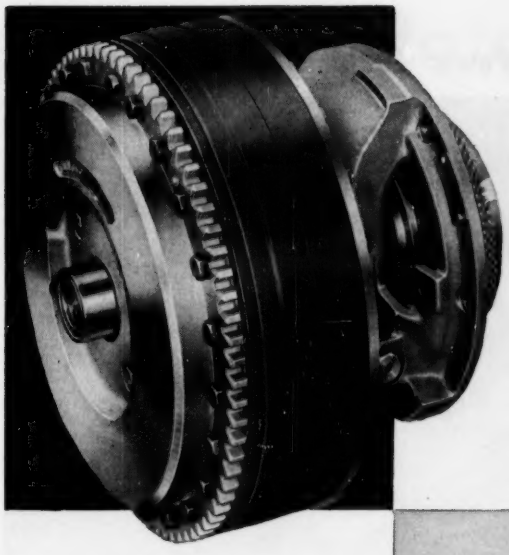
Here's How Tens-50 Compares:

Alloy and Method	Tensile Strength (psi)	Yield Strength (psi)	Elongation (per cent)
Forgings			
2014-T6	65,000	55,000	10
6061-T6	38,000	35,000	10
Permanent Molds			
Tens-50-T62	50,000	42,000	2.5
Tens-50-T6	45,000	36,000	3
356-T6	33,000	22,000	3
Sand Castings			
Tens-50-T6	42,000	32,000	3
356-T6	30,000	20,000	3



For Sale: Thermal Electrons . . .

First thermoelectric generator to go into production for consumer use is being offered by Pesco Products Div., Borg-Warner Corp., Bedford, Ohio. Propane flame provides the high-temperature source; heat converts via the thermocouple effect to electricity.



CASE®

"420" Industrial Loader gets more push-power for faster digging with Torque Converter Drive

For a machine that weighs only 7,120 lbs., the Case "420" Industrial Loader packs a lot of power. It's billed as the only low-priced wheel type loader actually designed for production digging assignments. With 12,000 lbs. drawbar pull and 4,600 lbs. break-out force, the 15 cu. ft. bucket gets heaping loads on every pass, even out of hard-packed materials.

Secret of this amazing power is Twin Disc Torque Converter Drive

. . standard equipment on the Case '420." Compared to direct mechanical drives, the torque converter provides up to 56% greater push-power at the all-important working speeds.

As the load increases, torque output is multiplied through an infinite number of speed ratios to overcome load resistance smoothly and automatically. Since the engine is not lugged down, the 21-gpm hydraulic pump delivers full break-out power at all times. No tractive effort is lost due to tire slippage, because the slippage occurs within the torque converter.

In addition to boosting power, the torque converter's fluid cushion absorbs shock loads to prevent damage to engine and power train. There's no need for clutching during the digging operation, so operator efficiency goes up while the problem of clutch wear and replacement disappears.

Add all these features together and you get this answer: More dirt moved in less time and with far less effort. A test of the Case "420" Front-End Loader will convince you that Twin Disc Torque Converter Drive belongs on all your earthmoving equipment.

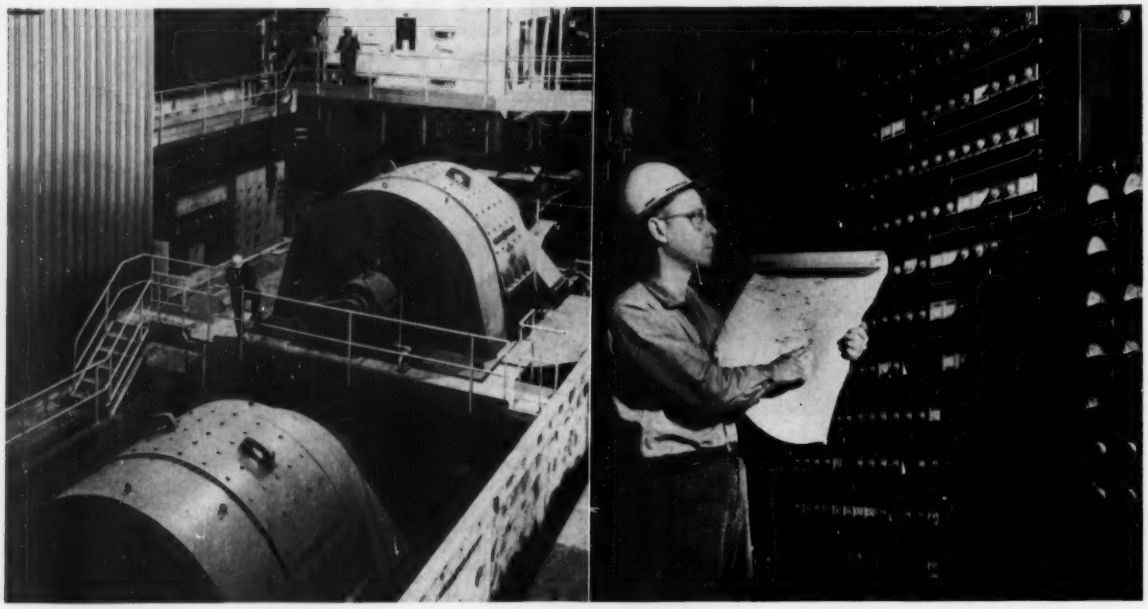
TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

TWIN DISC
Torque Converters

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

BRANCHES OR SALES ENGINEERING OFFICES: CLEVELAND • DALLAS • LOS ANGELES • NEWARK • NEW ORLEANS

High-Speed Rolling Mill Gets Nonrotating Power Equipment



Latest advancements in electrical power and control equipment are wrapped up in the design of a new 140-in. plate mill at Lukens Steel Co. The mill is the first in the U.S. to be rectifier powered (8000 kw at 750 v) and uses static switching equipment in place of conventional moving contactors (MACHINE DESIGN, May 14, 1959, Page 10). The mill's two 5000-hp, 40/80-rpm drive motors (left) and mill tables are controlled from a transistorized panel (right). A specially designed programming system (punched cards are not used) permits the operator to select varying degrees of mill automation. Use of static equipment, designed by General Electric Co., is expected to reduce maintenance and power costs. Rectifiers for example (pumpless ignitron mercury-arc tubes) are 94 per cent efficient.

Metals Matters

Shields for radiation . . .
can be constructed to any shape or size quickly and economically using high-density spheres made by P. R. Mallory & Co. Inc., Indianapolis, Ind. The spheres are made of a homogeneous alloy of tungsten, nickel, and copper called Mallory 1000. It's about 20 per cent better than lead when absorbing 100-MEV X-rays from a betatron. The spheres range in size from 1/16 to ¼ in. and pour easily to fill any void. When changes are made, the spheres can be reused in the new configuration without rework.

New shell material . . .
will make possible the casting of bigger, better, cheaper precision castings than ever before, according to the J. B. Rea Co. Inc., Santa Monica, Calif. In a process developed by Rea's Ferro Cast Div., basic techniques of investment casting are employed, but a thin coating surrounding disposable wax patterns replaces investment-filled steel flasks, cutting weight of the mold as much as 90 per cent and reducing dewaxing and curing time about 85 per cent. Cost goes down as size of part increases. The thin, uniform shell coating cools the poured metal more evenly and rapidly than investment material, providing a finer molecular grain structure and permitting the regulation of grain size in alloys which cannot be heat treated.

Spray-on zinc coat . . .
is not organic—can be applied by brush, spray, or roller—sets in a few hours without separate curing compound—is not affected by organic solvents—contains no volatile, flammable, or toxic components. It can be used in poorly ventilated areas and will not contaminate water or food products. Amercoat Corp., South Gate, Calif., calls its product *Zinkote*. It bonds both chemically and mechanically with bare steel surfaces. A coat only a few mils thick protects steel from weathering, abrasion, and salt spray. It can be used wherever galvanizing is suitable, even on large structures already in place.

Super-purity aluminum . . .
is available in the form of pig of various sizes, ingots, billets, pellets, coiled sheet, and foil from Aluminum Foils Inc., Jackson, Tenn. Guaranteed purity is 99.992 per cent; average purity is 99.996 per cent. This material's superior resistance to both atmospheric and chemical corrosion makes it suitable for use in the chemical and processing industries. Elongation values permit extremely intricate forming. Also used for trim, Raffinal super-purity aluminum produces clear, transparent anodized films, even at thicknesses of only 0.004 to 0.001 in. Properties of alloys, tradenamed Reflectal, compare to common aluminum alloys.

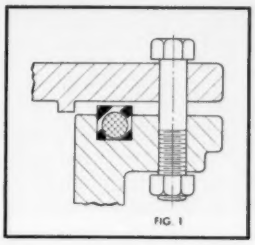
Technical data for gasket design and selection

Why close tolerances in resilient gaskets are rarely necessary

Tolerances in the size and shape of a gasket do not become critical if the gasket material chosen seals effectively over a wide compression range.

Armstrong cork-and-rubber compounds are typical of such wide range materials.

Because they are truly compressible, they decrease in volume under load, so tolerances in size may be as wide as .010", even in completely



confined space. In some applications, the wider tolerances allowed by compressible gaskets may effect savings in machining time.

The typical examples shown here illustrate how Armstrong cork-and-rubber materials help eliminate the need for close tolerances.

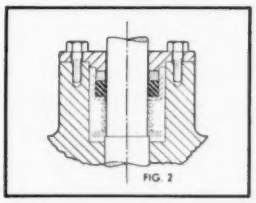


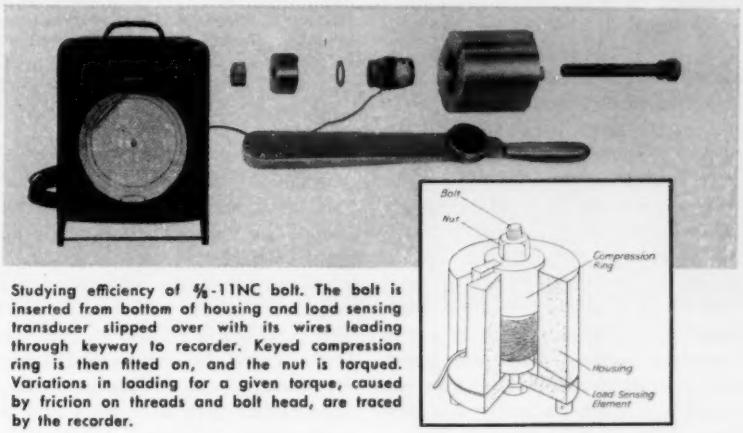
Figure 1 shows relative sizes of a resilient cork-and-rubber gasket and a non-compressible molded ring of comparable size. The cork-and-rubber compound permits wide tolerance in its size, whereas the molded ring must meet very close tolerances to allow perfect fit between the flanges.

Similarly, in figure 2, wide tolerance cork-and-rubber gaskets make an effective packing ring. Their true compressibility controls lateral flow and prevents excessive build-up of radial pressure on the shaft.

How varying bolt efficiencies affect flange loads, cause gasket leakage

Leaks often occur in gasketed joints where flange loads as calculated are thought to be adequate—or more than adequate—to create a seal. Such leaks are sometimes blamed on torque loss, when the real problem is inadequate initial flange pressure.

Data obtained with this device has led to a method of relating apparent flange pressures to actual flange pressures. This procedure compensates for loads that approach the values calculated from bolt torque.



Studying efficiency of ⅝-11NC bolt. The bolt is inserted from bottom of housing and load sensing transducer slipped over with its wires leading through keyway to recorder. Keyed compression ring is then fitted on, and the nut is torqued. Variations in loading for a given torque, caused by friction on threads and bolt head, are traced by the recorder.

The major reason is that flange loads arrived at mathematically almost never equal the true load on the gasket. The explanation is friction . . . friction on threads and bolt heads that soaks up torque and reduces the pressure available to squeeze the gasket.

Although it is generally known that friction causes variations in bolt efficiency, little data has been available to indicate the extent of the problem. As a result, arbitrary compensations for friction are usually too low.

Armstrong research engineers have developed a device (shown above) which measures the effect on bolt efficiencies of varying screw thread conditions. Dry or rough threads, for example, give low bolt efficiencies which develop actual gasket loads much lower than torque readings would indicate. Lubricated threads give high bolt efficiency and result in gasket varying conditions of bolt threads.

This data, combined with other new information on seal points of Armstrong resilient gasket materials, is useful in helping designers meet the minimum sealing conditions of a particular flange design and material.

Detailed information on this subject and other problems of gasket selection, design, and performance is contained in the new Armstrong Gasket Design Manual. Write for your personal copy.

New! Gasket Design Manual just printed. Write for a copy to Armstrong Cork Company, Industrial Division, 7512 Dean Street, Lancaster, Penna.

Armstrong GASKET MATERIALS

. . . used wherever performance counts

Peaceful Nuclear Plane Practical, Say Soviets

Gigantic Aircraft Would Pay Its Own Way

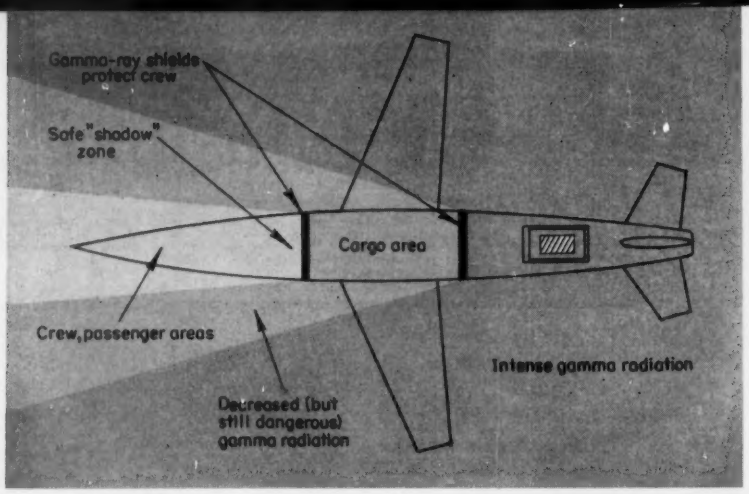
WHO'LL BE FIRST with the nuclear airplane? American experts concede the U.S.S.R. may have one already. The Russians aren't demonstrating hardware, but here are some ideas reported in their literature on designing an aircraft to house a reactor.

Distance and shielding are the only protection from radiation. In an aircraft, distance separating crew from reactor is limited—30 meters (100 ft) is about the practical limit, says one Russian specialist—so shielding must be counted on to do most of the job. But when the reactor is operating at maximum output, radiation level must be reduced by a factor of 10 million, and this requires 35 cm (14 in.) of lead. Lead shielding this thick is a tremendous load—a one-square-meter shield weighs about four tons—so shielding must obviously be kept to a minimum.

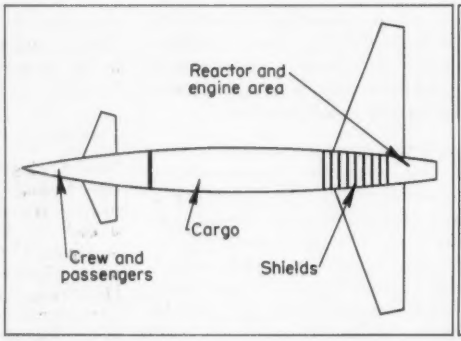
Although it adds considerably to aircraft weight, the shield-weight factor is tolerable in a large airplane. According to U.S.S.R. experts, the smallest practical nuclear airplane would weigh at least 100-120 tons, and a 200-ton aircraft is about the minimum that really appears attractive.

Many specialists believe the first nuclear airplane will be a bomber, since a bomber's three to five man crew would be comparatively easy to protect from radiation. But no one claims such a plane would be economical. However, transports powered by nuclear engines—aircraft for peaceful purposes—are also feasible, and the Soviets believe that, unlike the bomber, they would pay their own way.

While nuclear sky giants might not perform as efficiently as conventional aircraft, their enormous advantage—unlimited range — would make up for their disadvantages. Then too, as designers became more proficient, early improvements in the "monsters" could be expected. First cost of a nuclear transport is estimated by the Russians at $2 billion. But savings in fuel costs, reduction in operating expenses, etc., could be expected to make the craft far cheaper to operate than jet liners, so that the nuclear transport would rapidly amortize its cost.

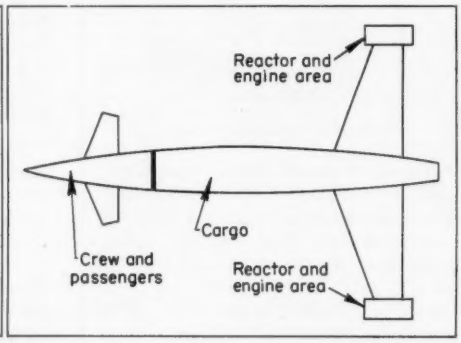


Two types of shielding will protect passengers and crew. Neutron shields, located near the reactor, not only safeguard the humans, they also keep the aircraft itself from becoming radioactive. Without the neutron shielding, no one could approach the aircraft for days after it had landed—even with the reactor removed. Russian designers do not plan to protect the airframe from gamma radiation, however, for they feel the weight of this shielding would be excessive. The two-shield gamma-ray system shown here protects only the humans. Crew and passengers sit far forward in the safe "gamma shadow" zone and leaves the intermediate zone (between shields) for cargo. Designing for two or more gamma-ray shields avoids excessive point loadings and distributes weight.

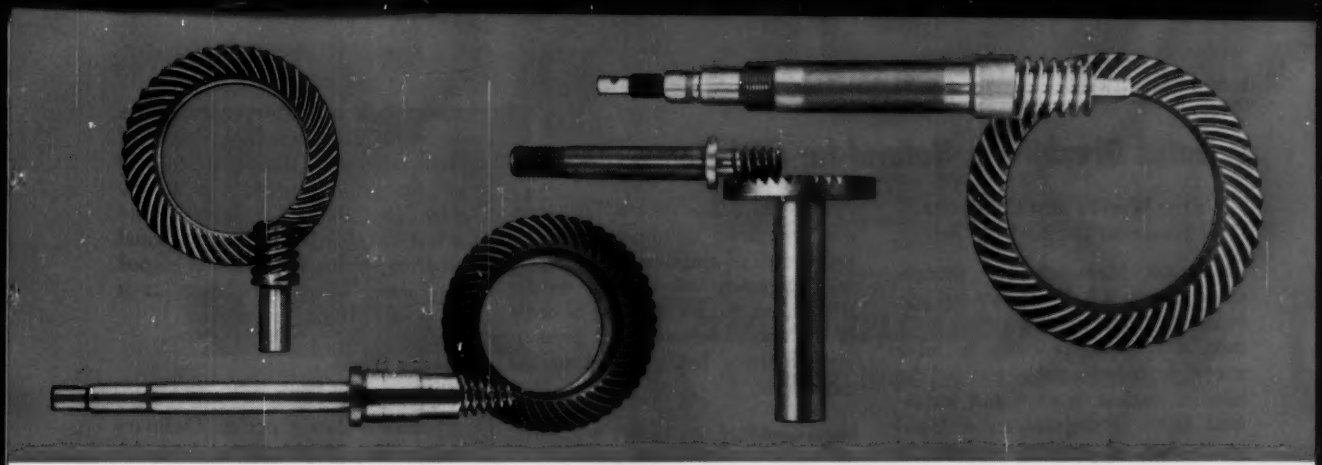


Heavy nuclear powerplants mounted in the tail of conventional aircraft are ruled out by Russian designers. The aircraft would be out of aerodynamic balance and would tend to pitch up in flight. Also, control surfaces so close to the center of gravity would have little effect. Some of the Russians feel a nuclear airplane should be designed with the reactor located near the center of gravity of a conventional airframe. However, more shielding would be needed than required by unconventional designs.

Canard-type aircraft offer certain advantages: Reactor (and c.g.) could be located near the tail; the airplane would not pitch in flight, and control surfaces (located far forward) would permit sufficient control. But the Canard design introduces a new problem: Stability is generally inadequate at landing and take-off speeds.

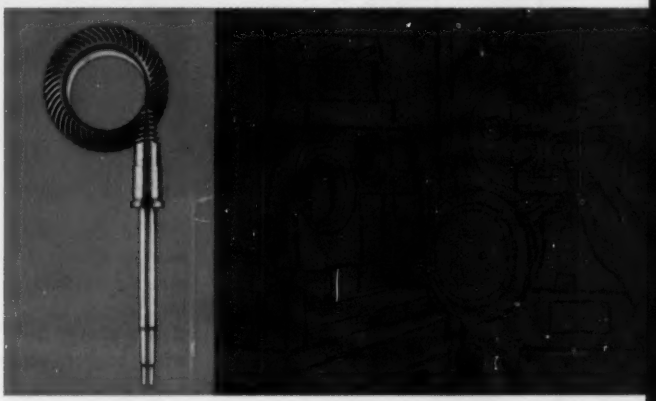


Wing-tip powerplants would locate reactors the greatest possible distance from the human crew. This type aircraft offers all the advantages of the canard type, and is more stable at low speeds. However, heavy atomic engines located at the end of long thin cantilever wings bring up questions on structural reliability.

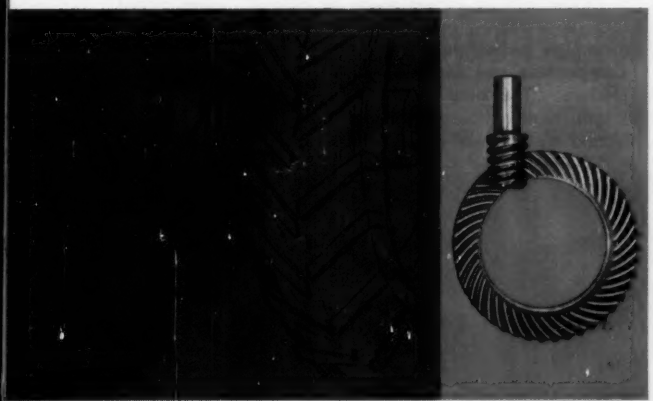


WHICH OF THESE HIGH-RATIO HYPOIDS IS "JUST RIGHT" FOR YOUR PRODUCT?

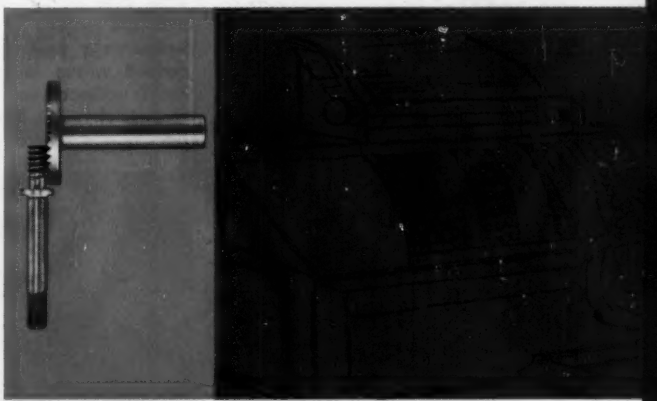
For hand tools. Where space is a problem—as in portable tools like this one—the high offset lets you design a more compact unit. Choose just the offset to solve your design problem with a more flexible, more compact unit than the corresponding worm and wheel.



. . . or machine tools. This high-offset pair lets you combine high reduction with strength, compactness and other advantages you might find profitable in designing machine tools. High-ratio hypoids can be produced on Gleason equipment for ratios of 1:10, 1:40 or even higher.



Big and strong. Where you need strength—as in farm machinery—high-offset hypoid pinions (with teeth which tend to "wrap around") are larger and stronger than corresponding bevel pinions. An extended shank on cylindrical pinions makes very rigid straddle mountings practical.



. . . or small and smooth. For smooth operation—as in office equipment that must run quietly—high-offset pairs provide smooth, quiet tooth action. Because teeth "wrap around" the pinion, you get continuous action—even with just one or two teeth! Grinders are available for applications requiring precision finish.

High-offset or high-ratio hypoids can be cut, tested, and quenched on the same Gleason equipment that is used on more familiar spiral bevel and hypoid gears. You can get more information about Gleason high-ratio hypoid gears by writing for free literature. Submit your prints for recommendations.

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Circle 418 on Page 19

Oriented Graphite: A Natural for High Temperatures

It's the World's Best Conductor Of Heat—on the Surface Only

WALTHAM, MASS.—A new process that converts a half-century old scientific curiosity into a practical commercial material promises to solve many high-heat problems in the missile, nuclear reactor and industrial fields. Pyrographite, a high-purity form of graphite produced in significant quantities for the first time by Raytheon Co., withstands temperatures ranging to 6700 F—higher than for any other known element. Moreover, at these high temperatures, the material remains strong, chemically inert, and impermeable to gases.

Key to Pyrographite's heat handling ability is its highly oriented crystal structure. Thermal and electrical conductivity is strongly anisotropic—higher (by several orders of magnitude) in a plane parallel to the surface than at right angles to it. Along the surface, Pyrographite is the world's best heat conductor; better even than copper or silver.

Thermal Properties (Excellent)

An increase in thermal conductivity of ceramic materials above some characteristic temperature is quite common and is associated with a radiation contribution to thermal conductivity; no such contribution has been shown to date for graphites or for Pyrographite. Consequently, the high-temperature insulating properties of Pyrographite compare even more favorably with those of conventional solid thermal insulators. This conclusion has been verified by very high temperature arc plasma and rocket motor tests.

Mechanical Properties (It's Tough)

At low temperatures Pyrographite has a strength-to-weight ratio higher than series 310 stainless steel. Above 2000 C, where normal graphite has one of the highest strength-to-weight ratios known, Pyrographite has a ratio five times as great as 310.

Various tests have been conducted with Pyrographite and normal graphite in highly erosive atmospheres, such as those produced by a high-velocity, high-temperature reducing stream of solids and gases. Pyrographite has shown little erosion compared to almost complete breakdown of graphite. This property, like many others, can be attributed to the high degree of order in the crystal lattice which presents low-reactivity basal planes to the gas stream.

Impermeability (No Leaks)

Of particular interest for applications in nuclear reactors is Pyrographite's impermeability to gases. Using a standard mass spectrometer leak detector, no permeation by helium has been detected. The material retains this property after heating to 2500 C and re-cooling—even in films as thin as 1 or 2 mils.

Electrical Properties (O.K.)

While complete data are not yet available, initial results show anisotropic electrical conductivity similar to that noted with heat. Resistivity along the surface increases with higher preparation temperatures, while at right angles to the surface it decreases. The degree of anisotropy is of the order of 1000 to 1 for material prepared at 2000 C. Resistivity along the layer planes is considerably less than for normal graphite, which is considered a good conductor; across the layers, it is far greater than for graphite.

Density (High)

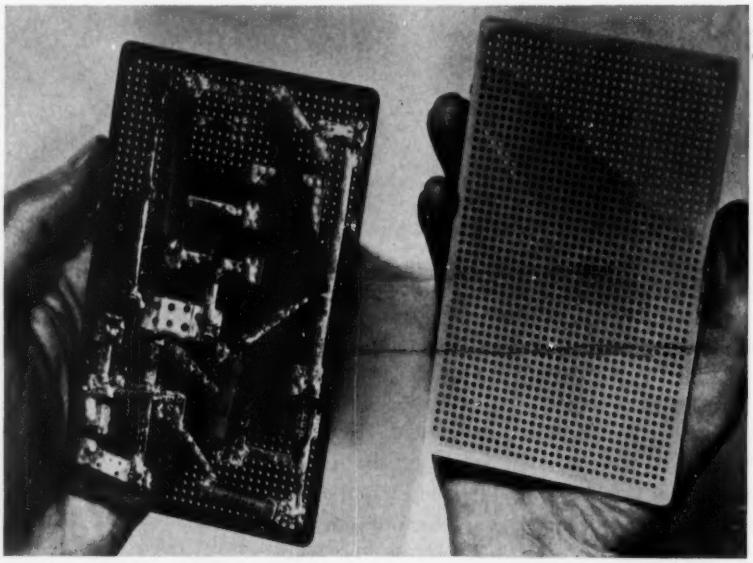
The theoretical density of normal graphite is 2.26 g per cc. Ordinary commercial graphites run from 1.6 to 1.7; densified graphites range from 1.7 to 2.0. Pyrographite has been prepared with measured densities as high as 2.22.

Applications (Wide Open)

Work to date has been concentrated chiefly on developing classified products for military applications. It is fully expected, however, that Pyrographite will be applied to a vast number of other products, both military and commercial. Real potential also lies in the extension of the same pyrolysis process to other materials such as Pyrographalloys, Pyrocarbides, and Pyrofibers.

Grid Board Tries Out Printed-Circuit Designs

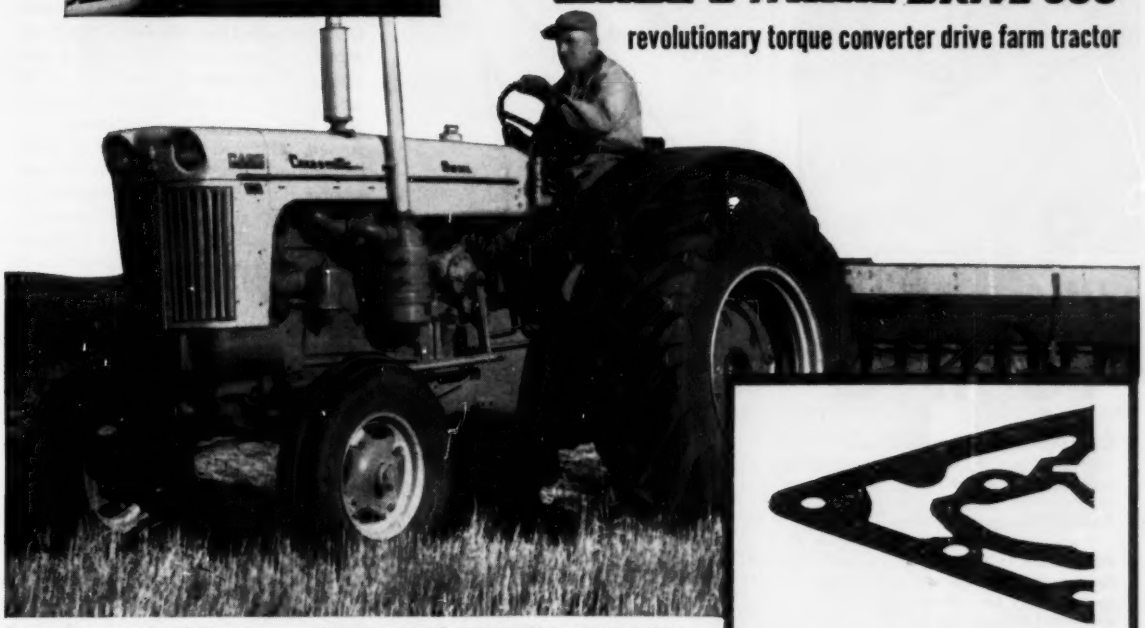
Printed-circuit prototype layouts can be quickly made on a reusable grid board. Designed by Corning Glass Works, Corning, N. Y., the board is clad on both sides with copper, and the copper can be etched away as desired. After circuit lines are marked on the face (with etching resist), excess copper is removed with hydrochloric acid and ammonium persulfate. Copper that remains forms the desired wiring layout. Components can be soldered in place more than 50 times without circuit-run failure. The board is made of Fotoceram, a glass-ceramic that has high strength, high temperature resistance, zero water absorption, and is nonflammable and dimensionally stable.



Cylinder head gasket is the VIC-2-FOLD metal-encased asbestos construction. It provides maximum sealing strength, permits close thickness control. Steel bottom layer, formed upward in cylinder openings, gives best burnout resistance. Copper top layer, formed down in other openings, gives best corrosion resistance.

Case-o-matic DRIVE 800

revolutionary torque converter drive farm tractor



From creep speed to full engine speed in any one of eight working ranges, using throttle control only—that's the new convenience feature of Case-O-Matic transmission in Case diesel tractors.

Sealed for Sustained Performance

The Case-O-Matic Drive 800 Diesel tractor is equipped with an efficient torque converter and a standard multiple-geared transmission plus a conventional direct drive. It is Case engineers' newest achievement in giving the tractor operator modern car-driving convenience. Case-O-Matic Drive senses the load—increases torque power up to 100% instantly, precisely, automatically—without clutching, shifting or stalling.

The 800's performance is insured with tightly sealed-in power flow from engine to transmission to power output shaft. And for dependable sealing, Case designers chose Victor gaskets and oil seals.

Sealing engines, transmissions and machinery of all types for highest efficiency has been a specialty service with Victor for a half-century. As has been the J. I. Case Co.'s experience, Victor can serve you best and most economically by working with you from the very start of a sealing specification. Your inquiry involves no obligation. Victor Mfg. & Gasket Co., P.O. Box 1333, Chicago 90, Ill. Canadian Plant: St. Thomas, Ontario.

Transmission case gasket is Victor Asbestoprene 233, selected for high crush resistance and resilience. This beater-mixed asbestos, synthetic rubber packing holds a tight seal under severest stresses of tractor service.

Case-O-Matic clutch shaft and power take-off shaft are sealed with Victor K3 Victoprene oil seal. This narrow-width design for compact housing provides controlled lip pressure sealing; coating of synthetic rubber. Also seals at toe and O.D.

Transmission power output shaft is dual-lip sealed with K4 Victoprene oil seal. Inner lip retains lubricant; outer lip excludes dirt. Victoprene on O.D. and toe also seals housing.

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Write for catalog and technical data to Dept. 9, Precision Tube Company, Inc., North Wales, Pa.

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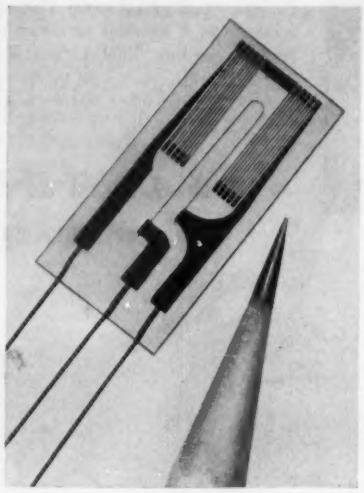

Universal Strain Gage Accurate Over 1200-F Span

Temperature-compensated strain gage can be bonded to any one of a broad variety of materials, i.e., it is universally temperature compensated. Developed by Electronics & Instrumentation Div., Baldwin-Lima-Hamilton, Waltham, Mass., the new instrument can be used between temperature limits of −350 and 850 F. It is designed with a platinum wire compensating element, contained within a Nichrome foil strain sensing grid. Inaccuracies due to rapid temperature change are minimized by this configuration, and an external circuit permits adjustment of the gage's temperature-response characteristics to compensate for almost any material.

NavOrd Fingers RF Wave As Weapon Mishap Culprit

Checks Fuses, Rockets For Sensitivity

SILVER SPRING, MD. — Radio and radar waves are sabotaging the American military. They set off explosives and missiles, cause fires, and burn military personnel.

But Naval Ordnance Laboratory and other military and civilian labs are now doing something about this un-American radiation. Research, centered on sensitivities of fuses and reaction-initiating devices, will eventually result in RF tolerance limits for all weapons and components. The program, complicated by the many different types of weapons and electrically initiated explosive components in operation, will test all types of ordnance exposed to all types of radiation.

Each weapon or component poses an individual problem. An early finding, for example, was that rockets in certain types of launchers were highly susceptible to accidental firing by radiation from deck-edge whip antennas.

RF hazards to explosives have plagued industry for some time. Electrical blasting caps pick up enough RF from nearby radio and TV transmitting antennas to explode. Construction crews today set up signs along highways near a blasting area, warning motorists of the danger and requesting that all mobile transmitters be turned off.

Fourth Enrico Fermi Award Goes to Eminent Nuclear Chemist

Dr. Seaborg Honored As Researcher, Educator

WASHINGTON—Atomic Energy Commission presented the Enrico Fermi Award for 1959 to Dr. Glenn T. Seaborg, a leading nuclear scientist and chancellor of the University of California. Dr. Seaborg, a well-known educator as well as researcher, is credited with being the discoverer or co-discoverer of plutonium, the transplutonium elements, and the isotopes plutonium 239 and uranium 233. In the words of the award, he "is a pioneer in the field of nuclear energy."

The award, consisting of a medal, a citation and $50,000, is only the latest of a long list of honors for Doctor Seaborg. In 1947 he was named one of America's ten outstanding young men and received the American Chemical Society's Award in Pure Chemistry; in 1948 he received the American Society of Swedish Engineer's John Ericsson Gold Medal; and in 1951 (with E. M. McMillan) he was honored with the Nobel Prize in Chemistry.

The doctor was co-discoverer of element 94 (plutonium) in 1940; discoverer of element 95 (americium) and 96 (curium) in 1944; co-discoverer of element 97 (berkelium) in 1949; element 98 (californium) in 1950; element 99 (einsteinium) in 1952; element 100 (fermium) in 1953.

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Steel lined with bronze, babbitt, copper or aluminum alloy
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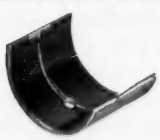
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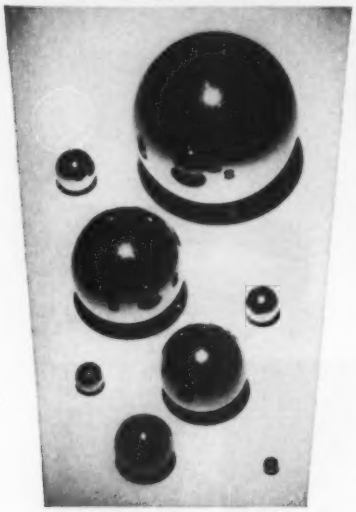

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EXTREME HARDNESS: 89-91 Rockwell A.

EXTRA-SMOOTH FINISH: 1 microinch r.m.s. or better.

HIGH PRECISION: ±.0001" on size and .000020" sphericity are standard. Furnished to .000010" on size and sphericity if desired.

These balls are available in ALL SIZES, standard and special, from .005" to 5". Sizes from 1/64" to 1" are in stock.

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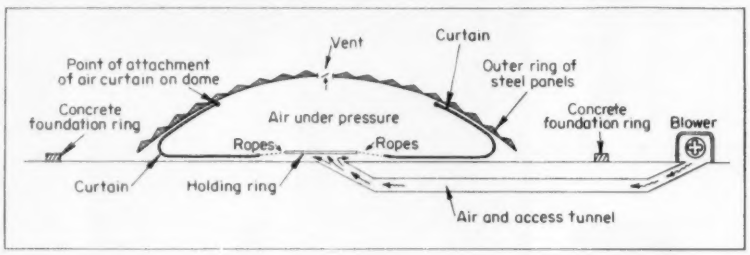
Built from the Top Down

Largest structure ever to go up from the top down is the Union Dome at Wood River, Ill. After the top was constructed, the dome was raised to successively higher levels by air pressure. Thus, much of the work around the periphery was done at ground level. Air pressure, contained by the giant nylon-fabric curtain attached to the dome's underside (at the 175-ft diam point), was regulated by the single vent at the top. As pressure was increased, the dome raised and additional rows of steel panels were welded to the periphery. When completed (in mid-1960), the 380-ft diam structure, built by Graver Tank & Mfg. Co., Div. of Union Tank Car Co., will house Union Tank's regional repair facilities.



'60 Cars Carry More Aluminum

DETROIT—Use of aluminum in automobiles is up 13 per cent in 1960, according to V. E. Flaherty, automotive industry manager for Kaiser Aluminum & Chemical Sales, Inc. Estimates set the net, or finished, weight of aluminum components at a per-car average of 56.2 lb for 1960 compared to 49.6 lb in '59 models.

Two important engineering advances by the industry this year, the new Pontiac integral wheel and the Corvair engine, Mr. Flaherty pointed out, were accomplished with aluminum. He predicts that aluminum bumpers, mufflers, and radiators will be ready for 1961 models.

Chevrolet's Corvair, with its six-cylinder aluminum engine, leads all U. S. models in aluminum usage with a total of 102.6 lb. Ford's Falcon carries 49.6 lb of aluminum and Chrysler's Valiant, 52.6 lb.

Plymouth leads all makes with the largest increase, 31.3 per cent, and Chrysler Corporation automobiles, as a group, again lead with an average of 69.9 lb per car.

Ford, this year uses the most aluminum trim, 13.7 lb. In all makes, the per-car average of aluminum trim increased from 9 lb to 9.8 lb, and the average weight of functional components jumped from 40.6 to 46.4 lb.

Meetings and Shows

Jan. 11-13—

Sixth National Symposium on Reliability and Quality Control in Electronics to be held at the Statler Hilton Hotel, Washington, D. C. Sponsors are Institute of Radio Engineers, American Society for Quality Control, Electronic Industries Association, and American Institute of Electrical Engineers. Additional information can be obtained from

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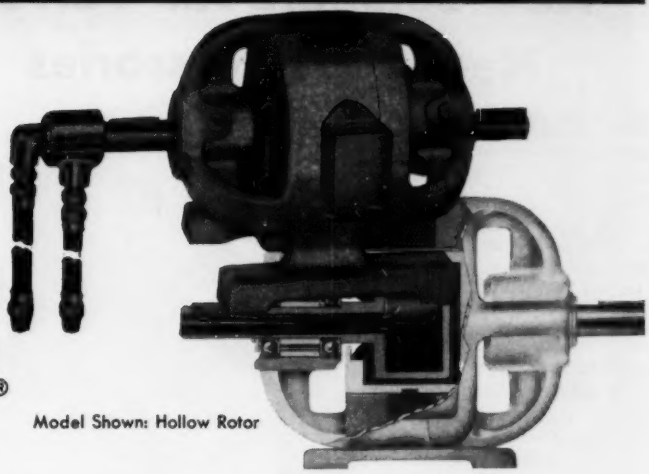

Model Shown: Hollow Rotor

for cycling, tension and speed control, braking...

The need for clutches (and brakes) for critical slip applications is now met by Vickers new water-cooled MAGNECLUTCHES. Whether for tension control of web materials ranging from tissue paper to strip steel, for cycling, start-stop or braking operation or wherever smooth and positive torque or speed control is required, the MAGNECLUTCH provides unexcelled performance over a wide range of operating and slip speeds.

With the exception of the salient feature of high heat dissipation ability, Vickers water-cooled units are identical to air-cooled MAGNECLUTCHES . . . and have all the unique and outstanding characteristics that are inherent in all Vickers dry magnetic particle units:

- *High heat dissipation capacity.*
- *Clutching or braking application.*
- *Complete torque controllability.*
- *Torque capacities from 10 lb-ft to 200 lb-ft.*
- *Unlimited service life (no wear on clutch surfaces).*
- *Full torque at zero slip.*
- *Torque independent of speed.*
- *Provide precise tension control with no material breakage and high productivity, eliminate operator error.*

EPA6100-3

SPECIFICATIONS

CLUTCH CATALOG NO.	MOUNTING	RATED TORQUE SIZE	[1]AVERAGE CONTINUOUS HEAT DISSIPATION CAPACITY, INITIAL ROTOR SPEED 1800 RPM (WATTS)	NON-EXCITED DRAG TORQUE	[2]D. C. COIL CURRENT FOR RATED TORQUE (98V DC)	[3]MAXIMUM OPERATING SPEED (RPM)	WEIGHT (LBS.)
6-2-2 BR	Foot	10 lb-ft	200W	0.2 lb-ft	0.23 amp	2300 rpm	29
6-2-2 WC	Foot	10 lb-ft	400W	0.2 lb-ft	0.23 amp	2300 rpm	28
6-2-3 BR	Foot	45 lb-ft	630W	0.6 lb-ft	0.51 amp	2300 rpm	74
6-2-3 WC	Foot	45 lb-ft	1260W	0.6 lb-ft	0.51 amp	2300 rpm	72
6-2-4 BR	Foot	100 lb-ft	750W	1.0 lb-ft	0.46 amp	2300 rpm	124
6-2-4 WC	Foot	100 lb-ft	2250W	1.0 ft-lb	0.46 amp	2300 rpm	122
6-2-6 BR	Foot	200 lb-ft	860W	2.0 lb-ft	0.92 amp	2300 rpm	233
6-2-6 WC	Foot	200 lb-ft	2580W	2.0 lb-ft	0.92 amp	2300 rpm	230

[1] In applications involving repetitive braking, high inertias, etc., it is recommended that our engineers review your data.
[2] Coils For Other Voltages Wound to Order.
[3] Higher Operating Speeds Attainable With Special Fittings.

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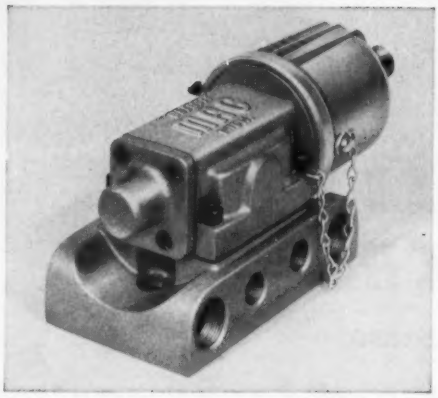
New Solenoid Air Valves Need No Accessories

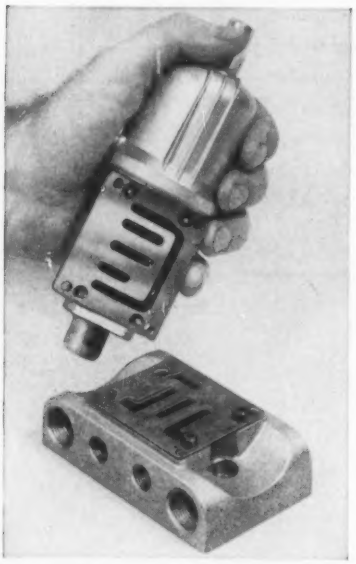
Now available for the first time are solenoid operated air valves complete with all accessories at 'bare valve' prices. Available in ¼, ⅜, and ¾ in. port sizes, they come in single- and double-solenoid types in 3-way, 4-way and 4-way 5-port models.



Features include: solenoids interchangeable on all models of a given size; pre-wired plug-in type bases, eliminating customary wiring; standardization of bodies and bases for interchangeability; unusual compactness; elimination of troublesome fasteners in solenoid assembly (which floats in rubber).

All valves are equipped with screwdriver or ball type manual solenoid operators with lock-in and lock-out feature.

Manifold type bases with common inlet exhaust, and conduit, available on ¼ in. models. For complete information, ask for MAC catalog #60.



Plug-in Connectors Now Standard on All MAC Solenoid Valves

Pre-wired bases, into which you simply plug in the valve body, are now standard on all MAC solenoid valves—both direct-solenoid and solenoid-air types. Bases are identical for single- and double-solenoid valves of a given size.

The same principle is also applied to the "add-a-unit" manifold type bases available for all MAC solenoid valves. With these, from 2 to 10 valves can be coupled with common inlet, exhaust and conduit. Individual valves can also be isolated or pressure fed in from each end.

With plug-in leads provided on all solenoids, wiring of valves has been reduced to the utmost in simplicity.

NEW!

Write today for this free air-valve manual and catalog.

You'll be surprised at how much time it will save you in picking just the right valve for your application. Ask for Catalog #60.

advances in
PNEUMATICS

MAC

evolution of valve seals...

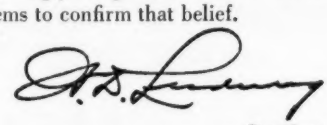
While metal-to-metal seals work well in hydraulic valves, where inherent leakage is accepted, positive leakproof sealing is mandatory in air valves. Flexible seals are today accepted as vital and they must be so designed that sealing efficiency increases with pressure. The seal should be self-cleaning so that foreign matter won't cause leakage.

At one time O-rings were thought to be the answer. O-rings are excellent for static sealing or where travel is short. O-rings are unsatisfactory, however, when used as valve seals crossing an orifice due to the shearing action.

Developing the best design and compound for air-valve seals was a long and tedious job, since elasticity, durometer hardness, compression set, and co-efficient of friction are also important factors.

Experience to date has proven that the best valve seal is a special Buna-N base self-lubricating oil-resistant compound—bonded to the metal to keep it from distorting.

This is the type of seal used in MAC valves. We believe it represents an ideal combination. At least, their amazingly long life in MAC valves seems to confirm that belief.



President

MAC

MECHANICAL AIR CONTROLS, INC.
18030 Capital, Oak Park • Detroit 37, Michigan

Circle 425 on Page 19

IRE headquarters, 1 E. 79th St., New York 21, N. Y.

Jan. 12-15—

Society of Plastics Engineers. Annual Technical Conference to be held at the Conrad Hilton Hotel, Chicago. Further information can be obtained from Mr. T. A. Bissell, Executive Secretary, SPE, 65 Prospect St., Stamford, Conn.

Jan. 15—

Malleable Founders Society. Semiannual Meeting to be held at the Hotel Sheraton - Cleveland, Cleveland. Further information is available from society headquarters, 781 Union Commerce Bldg., Cleveland 14, Ohio.

Jan. 20-22—

American Management Association. Conference on Utilizing Technology to be held at the Hotel Roosevelt, New York. Additional information can be obtained from AMA headquarters, 1515 Broadway, New York 36, N. Y.

Jan. 25-28—

Institute of the Aeronautical Sciences. Annual Meeting to be held at Hotel Astor, New York. Further information is available from IAS headquarters, 2 E. 64th St., New York 21, N. Y.

Jan. 25-28—

Plant Maintenance and Engineering Conference to be held at Convention Hall, Philadelphia. (Conference dates are Jan. 25-27.) Further information can be obtained from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

Jan. 26-27—

Society of Vacuum Coaters. Third Annual Meeting to be held at the Hotel Biltmore, New York. Technical sessions will be on Wednesday. Further information is available from John H. Smith, Application Engineer, Technical Services Dept., Consolidated Electrodynamics Corp., 1775 Mt. Read Blvd., Rochester 3, N. Y.

Jan. 31-Feb. 5—

American Institute of Electrical Engineers. Winter General Meeting to be held in New York. Further information is available from AIEE headquarters, 33 W. 39th St., New York 18, N. Y.

Feb. 1-4—

American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc. Semiannual Meeting to be held concurrent with the Second Southwest Heating and Air-Conditioning Exposition, which is under the auspices of ASHRAE, in Dallas. Headquarters for the society meeting will be the Baker Hotel; the exposition will be in Memorial Auditorium. Further information is available from ASHRAE, 234 Fifth Ave., New York 1, N. Y.

Feb. 1-5—

Instrument Society of America. Instrument-Automation Conference and Exhibit to be held at the Coliseum, Houston, Tex. Further information can be obtained from ISA headquarters, 313 Sixth Ave., Pittsburgh 22, Pa.

Feb. 2-4—

Society of the Plastics Industry Inc. Fifteenth Reinforced Plastics Div. Conference to be held at the Edgewater Beach Hotel, Chicago. Further information is available from SPI headquarters, 250 Park Ave., New York 17, N. Y.

Feb. 3-4—

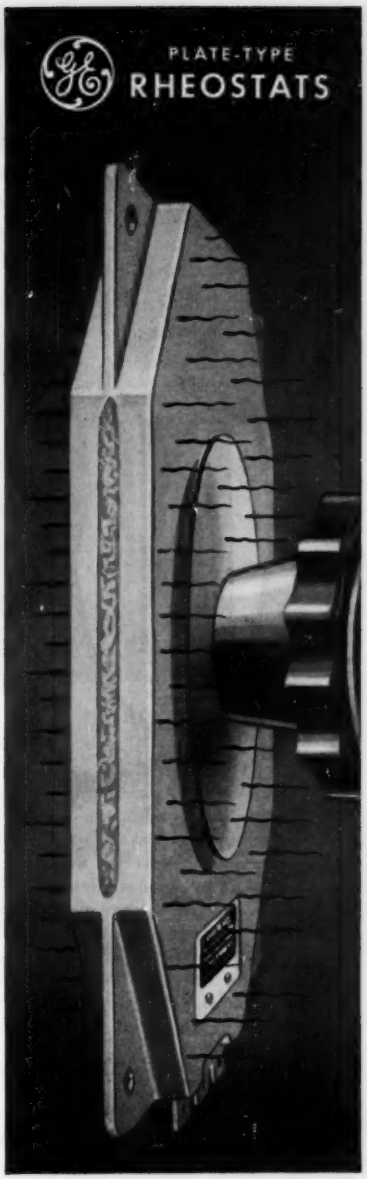
Midwest Welding Conference to be held at Illinois Institute of Technology, Chicago. Sponsors are Armour Research Foundation and the Chicago section of the American Welding Society. Additional information can be obtained from Harry Schwartzbart, Supervisor of Welding Research, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

Feb. 3-5—

Institute of Radio Engineers. Winter Convention on Military Electronics to be held at the Biltmore Hotel, Los Angeles. Additional information can be obtained from IRE headquarters, 1 E. 79th St., New York 21, N. Y.

Feb. 14-18—

American Institute of Mining, Metallurgical, and Petroleum Engineers. Annual Meeting to be held



DISSIPATE HEAT FROM BOTH SIDES

Greater, two-side heat dissipation means you can use a smaller, lower-cost rheostat for a given rating. G-E rheostats are metal-encased and cement filled to dissipate heat from both sides and increase watt capacity. See how you can benefit from greater heat dissipation; follow reader service instructions below. General Electric Company, Roanoke, Virginia. 784-21

Progress Is Our Most Important Product

GENERAL ELECTRIC

Circle 426 on Page 19

Chace THERMOSTATIC BIMETAL

ACTUATES ANOTHER PRECISION PRODUCT

The Therm-O-Disc ADJUSTABLE FURNACE FAN CONTROL

Thermo-O-Disc, Inc. Mansfield, Ohio

The Type AF-3 Adjustable Furnace Fan Control is a new product of Therm-O-Disc, Incorporated, for use with (or without) their similar adjustable or non-adjustable Furnace Limit Controls. This equipment stresses dependability, thermal sensitivity, and trouble-free life, plus adjustability within a range of 90°. The pointer indicates the turn-on temperature of the blower. Its snap-acting switch mechanism and heavy-duty contacts provide high electrical ratings up to 300°F., with full load amperages of 8.0 and 4.0 at 115 v. and 230 v. respectively. The control is listed by UL and C.S.A. An outstanding feature is the Chace precision bimetal sensing element which is mounted well into the air stream and provides quick response to temperature change.

In our more than a third of a century as producers of precision thermostatic bimetal, we've known and supplied hundreds of manufacturers of temperature actuated devices. Many have come from modest beginnings to become important factors in their industries and important customers of W. M. Chace Company. We are grateful, not only for their continuous patronage, but also for the millions of opportunities their combined sales have given us. For each product in the hands of a consumer is another chance for us to prove to our customer that his choice of Chace Thermostatic Bimetal was a good one. Whether he buys coils, strips or completely fabricated elements or assemblies of his design, he knows he can launch his new product with complete assurance, if the actuating element is Chace Thermostatic Bimetal.

While your new temperature actuated device is in the preliminary design stage, send for our booklet, "Successful Applications of Chace Thermostatic Bimetal." It's full of design engineering data with illustrated examples of uses of bimetal. Remember, too, that our 29 types of precision bimetal are available in strips, coils or completely fabricated elements of your design.

W. M. CHACE CO.
Thermostatic Bimetal
1616 BEARD AVE., DETROIT 9, MICH.

at the Statler-McAlpin Hotel, New York. Further information is available from AIME headquarters, 29 W. 39th St., New York 18, N. Y.

Feb. 18-20—

National Society of Professional Engineers. Winter Meeting to be held at the Broadview Hotel, Wichita, Kans. Additional information can be obtained from NSPE headquarters, 2029 K St. N.W., Washington 6, D. C.

Feb. 24-25—

Malleable Founders Society. Technical and Operating Conference to be held in Cleveland. Additional information can be obtained from society headquarters, 781 Union Commerce Bldg., Cleveland 14, Ohio.

March 7-8—

Steel Founders' Society of America. Annual Meeting to be held at the Drake Hotel, Chicago. Further information can be obtained from society headquarters, 606 Terminal Tower, Cleveland 13, Ohio.

March 16-18—

National Association of Corrosion Engineers. Annual Meeting to be held in Dallas. Additional information is available from NACE headquarters, 1061 M & M Bldg., Houston 2, Tex.

"We must be working on the same project."

. . . a unique combination

Houghton is the only manufacturer who can offer you a complete choice of packings and a complete choice of fluids to meet every industrial hydraulic requirement.

To work together, efficiently and safely, packings and fluids must be compatible and well-engineered. And no one is better qualified to tell you which packing will work best with any particular type of fluid—than the manufacturer who designs, formulates and produces all types of both. (It's also your guarantee of a completely unbiased recommendation.)

Take advantage of this unique background and experience in both hydraulic packings *and* fluids by calling your Houghton Man today—or write: E. F. Houghton & Co., 303 W. Lehigh Ave., Phila. 33, Pa.

VIM Leather and VIX-SYN Rubber PACKINGS
HOUGHTO-SAFE and HYDRO-DRIVE FLUIDS

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E. F. HOUGHTON & CO.

Ready to give you on-the-job service

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Circle 428 on Page 19

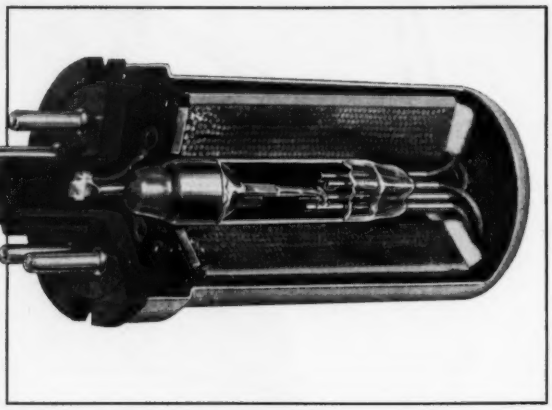
BISHOP Tubular Products NEWS

"METALS FOR PRECISION AND PERFORMANCE"

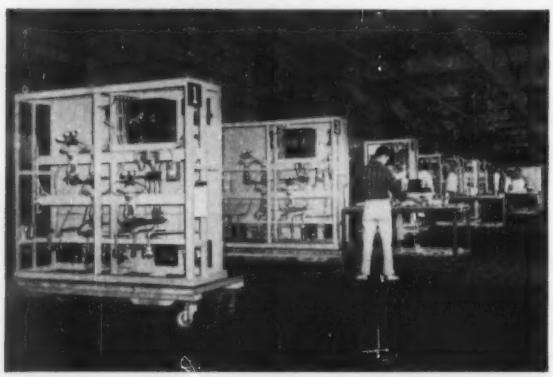
C. P. CLARE'S MERCURY-WETTED CONTACT RELAYS PERFECTLY SEALED WITH GLASS-TO-METAL SEALING ALLOY

C. P. Clare & Company, Chicago, Illinois, produces a complete line of mercury-wetted contact relays characterized by long life, high speed of operation and no contact bounce. To supply relays that have a conservative life expectancy of more than a *billion* operations requires absolute perfection in all phases of manufacturing. C. P. Clare uses BISHOP's #52 alloy tubing for the critical tubular stems of these relays. Mercury and hydrogen at 150 psig are introduced through this connecting stem—which is then sealed off by welding and forging. Can glass-to-metal sealing alloys solve any of your problems? BISHOP makes a complete line . . . use the coupon for details.

Circle 429 on Page 19



TUBING TAKES 5,400 PSI IN HONEYWELL'S MISSILE CHARGING SYSTEM



Super pressure stainless steel tubing connects many components of the cubicles illustrated. Minneapolis-Honeywell's Missile Equipment Division, Pottstown, Penna. builds these control cubicles that make up the gas charging system for the Bomarc missile. BISHOP supplies Honeywell with two sizes of 304 seamless super pressure tubing for this application. During charging of the missile, tubing handles pressures up to 5,400 psi. If you use small diameter tubing—super pressure, commercial quality or other—consider BISHOP. Use the coupon for a copy of BISHOP's Tubular Products Bulletin.

Circle 430 on Page 19

J. BISHOP & CO.

platinum works

FOR HELPFUL DATA USE THIS HANDY COUPON

- ☐ Glass-To-Metal Sealing Alloy Data
- ☐ Tubular Products Bulletin No. 12
- ☐ Special Tubing Data
- ☐ Platinum Products Catalog No. 4

Check information you'd like and mail to
J. BISHOP & CO.,
45 King St., Malvern, Penna.

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Company
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Tubular Products Division

45 KING STREET, MALVERN, PENNA.

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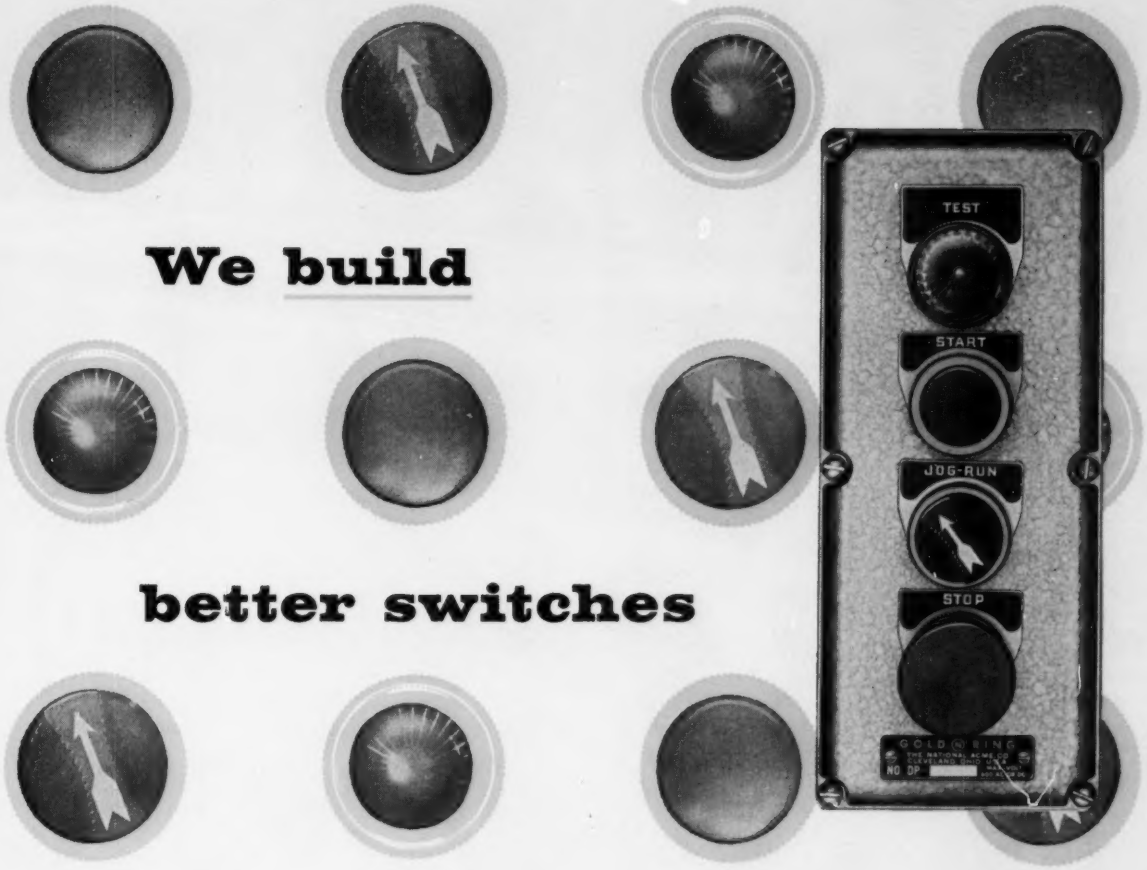
THIS IS THE BISHOP LINE:
Products of all the Platinum Metals...
Small diameter Stainless Steel, nickel and special alloy tubing



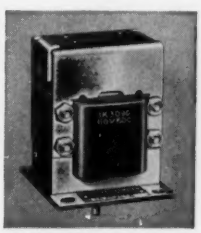
We build better switches because we can't buy them

...IT'S AS SIMPLE AS THAT...AND THEY COST NO MORE THAN OTHER SWITCHES

We had to build Gold-N-Ring Control Switches to meet our own high reliability specifications . . . our reputation was a part of this important fact. We're machine tool builders. We can't afford to be responsible for costly down-time on important capital investment equipment due to inferior control switches. That's why we build them like precise machine tools . . . and why it will pay you to check with us.

A wide range of basic units meets practically every need . . . as well as completely assembled stations in 1 to 4 button sizes to meet your electrical specifications. Ask our representative to call, or send for Bulletin ECS-56 . . . the complete selection and ordering guide.

LIMIT SWITCHES. A full line, originally designed for machine tool applications but now used wherever the highest reliability factors are required. Bulletin EM-51.



SOLENOIDS. A full line of standard and custom units for AC or DC. Push or pull types with capacities up to 25 lbs. Bulletin EM-52A.

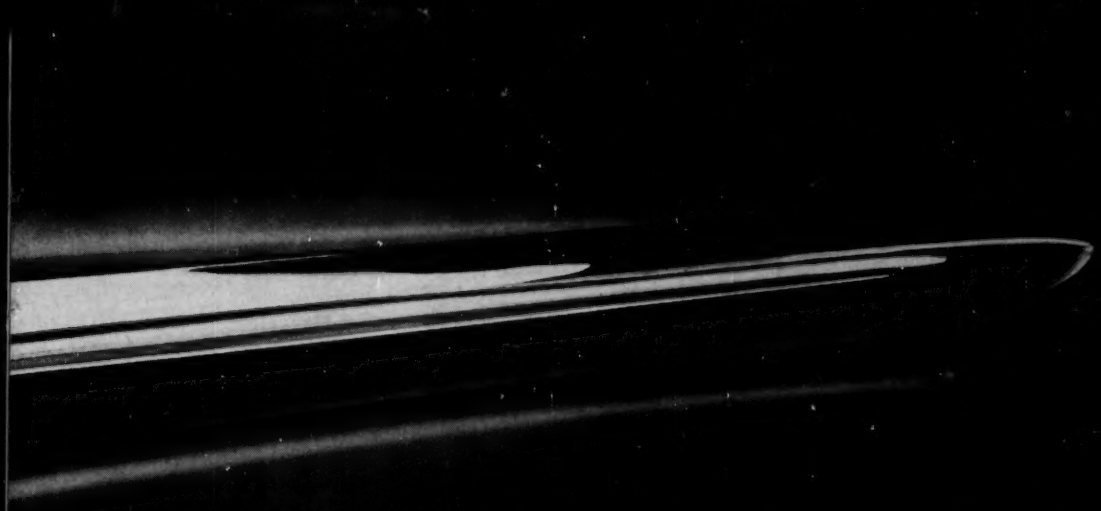
ELECTRICAL MANUFACTURING DIVISION

National Acme

THE NATIONAL ACME COMPANY
188 E. 131st STREET
CLEVELAND 8, OHIO

Circle 431 on Page 19

Form your own opinion A missile in flight? . . . A blacksmith's anvil? . . . The tail fin of an automobile?

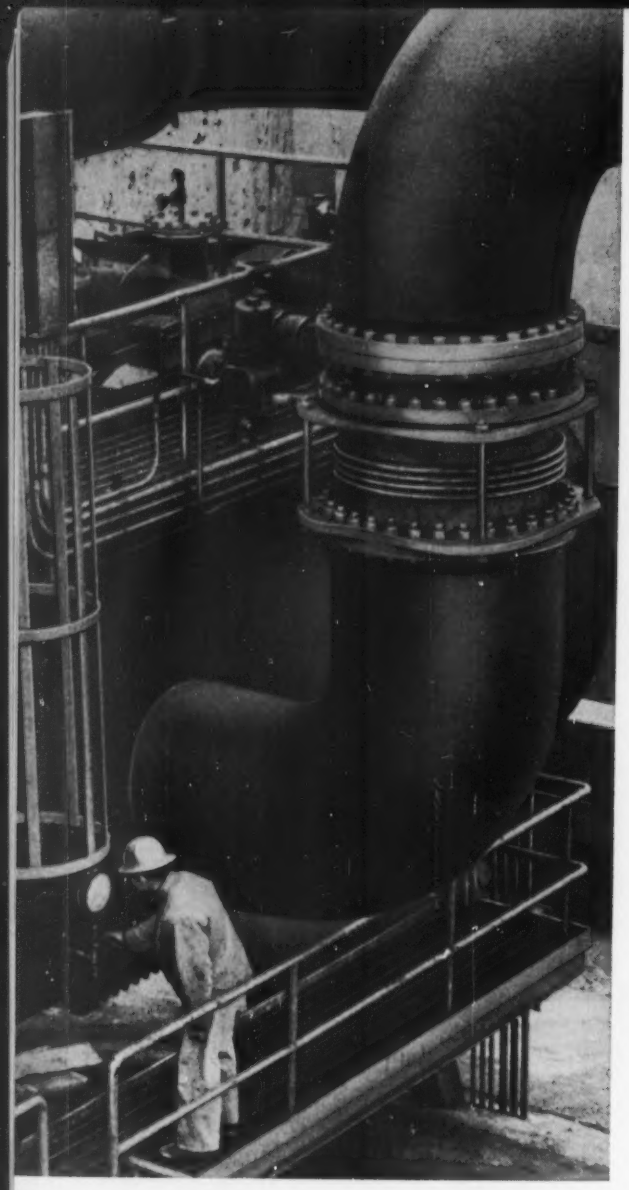


STEELS FOR DESIGN

The "fin" is right—it is made of steel . . . ductile enough to stretch a point, yet strong enough to stand firm.

For some other formable examples of steel, turn the page ▷ ▷ ▷

Please direct inquiries to advertiser, mentioning MACHINE DESIGN



STEELS FOR DESIGN

Stainless Steel An expansion joint in a piping system absorbs movement which might otherwise result in reduced life or even complete destruction of vital equipment and piping. One of the best types is the flexible, corrugated Stainless Steel bellows type as manufactured by Zallea Brothers of Wilmington, Delaware.

To produce these bellows, a sheet of Stainless Steel is rolled into a cylinder and welded lengthwise by special automatic equipment. This cylinder is then formed within steel dies by imposing internal hydraulic pressures as high as 4500 psi while compressing the cylinder. The smoothly shaped, cold formed bellows which results are capable of absorbing many cycles of compression, extension, rotation or lateral deflection. Because the bellows are Stainless Steel, they are corrosion resistant, maintenance-free, and capable of prolonged service under severe temperature and pressure conditions.

USS "T-1" Steel Shaped like a giant seashell, a turbine scroll case must withstand tremendous pressure. Water gushes through the conch in an ever-tightening spiral before shooting into the blades. Chicago Bridge & Iron Company used USS "T-1" Constructional Alloy Steel for the shells of four of the largest scroll cases in the Noxon Rapids Dam in Montana. Because of the exceptional strength of "T-1" Steel—115,000 psi minimum tensile strength—the walls could be made nearly 50% thinner and 50% lighter than carbon steel walls. Freight costs were lower. And because there was considerably less weight, the foundations for the cases could be made lighter and less expensive.

USS MAN-TEN High-Strength Steel Manufacturers have turned to high-strength steels to increase the strength of earthmovers without adding to their weight. LeTourneau-Westinghouse Company built their Model B scraper with USS MAN-TEN Low-Alloy High-Strength Steel in the yoke structure, side sheets, body truss tubes, and apron arms. MAN-TEN steel has a yield point of 50,000 psi—about 50% higher than carbon steel. This extra strength also permits designs with thinner, lighter sections that can reduce weight as much as 1/3 with no loss of strength. And though MAN-TEN steel is exceptionally strong, it is not difficult to form. In fact, MAN-TEN steel frequently simplifies fabrication because it can be used in lighter gages.

USS, MAN-TEN, and "T-1" are registered trademarks

United States Steel USS

Externally upset tube includes unusual boss... eliminates three parts

A request for COMMERCIAL design assistance on this barrel blank produced a savings of over 30% for the customer.

Originally the part was a weldment made from a tube, two flanges and a boss. Now the complete barrel blank is "Task-Forged" by externally upsetting only one piece of tubing in a patterned die designed and developed by COMMERCIAL. This resulted in closer tolerances and less distortion than the previous method. In addition, as an upset forging the part now possesses added tensile and torsional strength resulting from controlled grain flow while the metal is being displaced. Even more... the part now has a more efficient metal distribution.

Material saving: 15%. Reduced machining time: 30%. Overall customer benefit: a better, stronger part ... lower cost!

Barrel Blank
from SAE 1020 seamless tubing 3⅛" O. D. x 13/32" wall. Finished length 10.062".

How ingenuity in upsetting tubes cuts costs of unusual parts

Internal upsetting in ONE pass instead of four reduces net cost 25%

Note the neck of this one piece CO_2 cartridge; it's four times the wall thickness of the tube. After thorough analysis by COMMERCIAL, it was found that it could be internally upset in only *one pass*... instead of four. This meant that critical tolerances had to be maintained while three times more stock was gathered than permitted by conventional practice!

CO_2 Cartridge Tube
from SAE 1020 steel tubing 1⅜" O.D. x .123" wall. Finished length 7".

As pioneers in upset forging, the COMMERCIAL "Task-Forging" team has learned to go further... combining advanced design and metal displacement know-how to actually improve the physical properties of a forging while reducing its cost to the customer.

Formerly the neck of this cartridge was sealed with a 100% machined insert. Thanks to COMMERCIAL "Task-Forging" ingenuity, two machining operations and the assembly of the insert into the tube have been eliminated.

Result: a one piece pressure vessel with immeasurably increased strength ... at lower cost!

If you use parts, perhaps you too will discover "Task-Forging" savings now hidden. Send print or part for estimate... no obligation. Address: Commercial Shearing & Stamping Company, Dept. S-50, Youngstown 1, Ohio.

COMMERCIAL shearing & stamping

Circle 432 on Page 19

Circle 433 on Page 19→

Cleaner, cooler operation . . . less maintenance . . . longer, trouble-free life

HERE'S WHY: Ordinary d-c motor ventilation systems draw air in at the commutator end, contaminate windings by drawing carbon dust from commutator brush wear *into* the machine. In the new Life-Line® "H," this air flow is reversed. Air and carbon dust are expelled at commutator end . . . assuring cleaner, cooler windings . . . longer motor life . . . less maintenance.

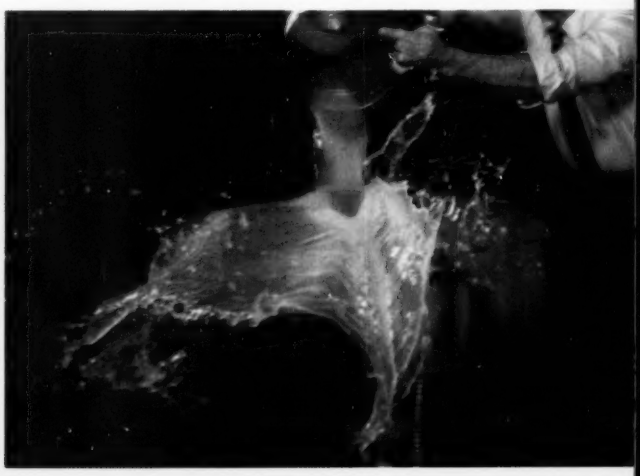
Plus . . . these other important advantages .....

YOU CAN BE SURE...IF IT'S Westinghouse

These exclusive features of the new Westinghouse Life-Line "H" d-c motor guarantee top performance . . . longer, trouble-free life

TEN TIMES LONGER INSULATION LIFE . . . New silicone insulation in Westinghouse Life-Line® "H" d-c motors and generators stands up under temperatures which turn ordinary insulation to a cinder. High-temperature silicone insulation is used with the full complement of iron and copper required for low Class B temperature. Result: Life-Line "H" shrugs off emergency overloads and abnormal ambients to keep production rolling, maintenance down.

GREATER PROTECTION . . . most complete and advanced protection available in dripproof industrial d-c machines. Elimination of uncovered side openings . . . heavy, cast end brackets . . . effective seals throughout . . . all combine to provide outstanding resistance to liquids, vapors and dirt. This means longer life with greater reliability . . . minimum maintenance under all operating conditions.



FASTEST RESPONSE . . . 35 per cent increase in commutating ability . . . up to 55 per cent lower mechanical inertia . . . and up to 30 per cent reduction in electrical inertia mean that the new Westinghouse Life-Line "H" d-c motor provides the fastest acceleration, quickest reversing and closest speed regulation. This means more production, better product quality, minimum complexity of control.

SIMPLIFIED MAINTENANCE . . . With the new Life-Line "H," maintenance is not only substantially reduced but periodic inspections are also greatly simplified. For example: as shown above, Uniforce brushholder fingers lock out . . . brushes can be inspected or changed with one hand. And Uniforce tension remains constant throughout brush life . . . no need to adjust pressure as brushes wear.

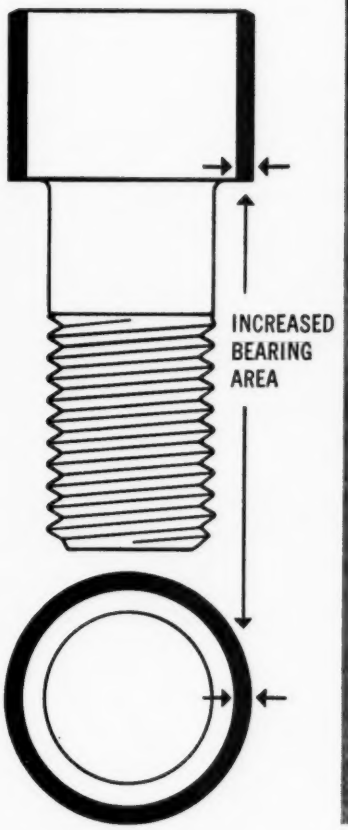
For information about the ways you can profitably put the new Life-Line "H" motor to work, contact your nearby Westinghouse representative. Or, write Westinghouse Electric Corporation, P. O. Box 868, 3 Gateway Center, Pittsburgh 30, Pa. JI-22122

YOU CAN BE SURE...IF IT'S Westinghouse

A MAJOR DEVELOPMENT IN SOCKET CAP SCREW DESIGN!

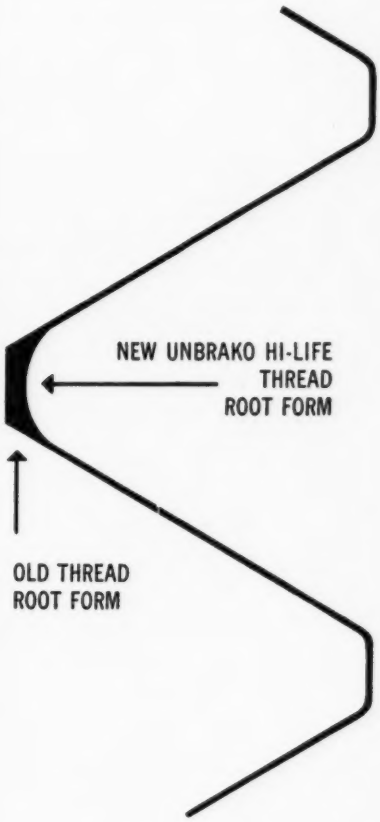
UNBRAKO *pHd** with Hi-Life thread— the advanced fastener for the 60's

Stronger in the head



UNBRAKO pHd design features increased bearing area under the head, bigger wrenching socket; provides up to 2⅓ times as much holding power without indenting bolted material. By permitting higher preloading, pHd helps eliminate fatigue failures, reduces possibility of screws working loose under shock and vibration.

Stronger in the thread

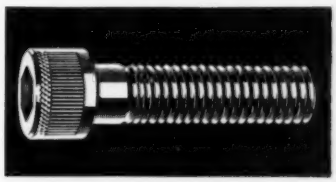


New UNBRAKO Hi-Life thread form has smoothly radiused root, slightly more metal at minimum cross section. Result: up to 100% greater fatigue life, plus a bonus in added tensile strength. Only UNBRAKO gives you the new, larger pHd head design and the improved Hi-Life thread . . . in a standard screw at no extra cost.

Anticipating tomorrow's demands today, SPS now offers you a standard socket head cap screw that incorporates both the UNBRAKO pHd design (1960 Series) *and* the new UNBRAKO Hi-Life thread.

This combination gives you a fastener that is unequaled in strength and performance. Because of its increased bearing area and bigger socket, you can tighten it tighter without deforming screw or bolted material. Thus you get more holding power—up to 2⅓ times as much, in fact. And because of both increased bearing area *and* new radiused thread root, the UNBRAKO pHd Hi-Life is almost twice as strong in fatigue.

The pHd head and Hi-Life thread —both originated by SPS—are tangible results of a continuing program of basic research in the design and performance of threaded fasteners. And they reflect to no little degree SPS experience in developing special high-strength fasteners for aircraft/missile use. Nevertheless, this new UNBRAKO is available to you as a standard—at no increase in price. For complete data, write SPS—manufacturer of precision threaded fasteners and allied products in many metals, including titanium.



New UNBRAKO pHd socket head cap screws with Hi-Life thread are available now from your authorized industrial distributor in standard sizes ¼ through 1 inch, plain or cadmium plated. Available also with the Nylok† self-locking feature. NOTE: UNBRAKO pHd Hi-Life screws fit standard tapped holes, require no special gaging.

†T.M. Reg. U.S. Pat. Off., The Nylok Corporation

INDUSTRIAL FASTENER Division

JENKINTOWN 18, PENNSYLVANIA

SPS

*pHd stands for "proper head design"—a factor in higher product reliability

Circle 434 on Page 19

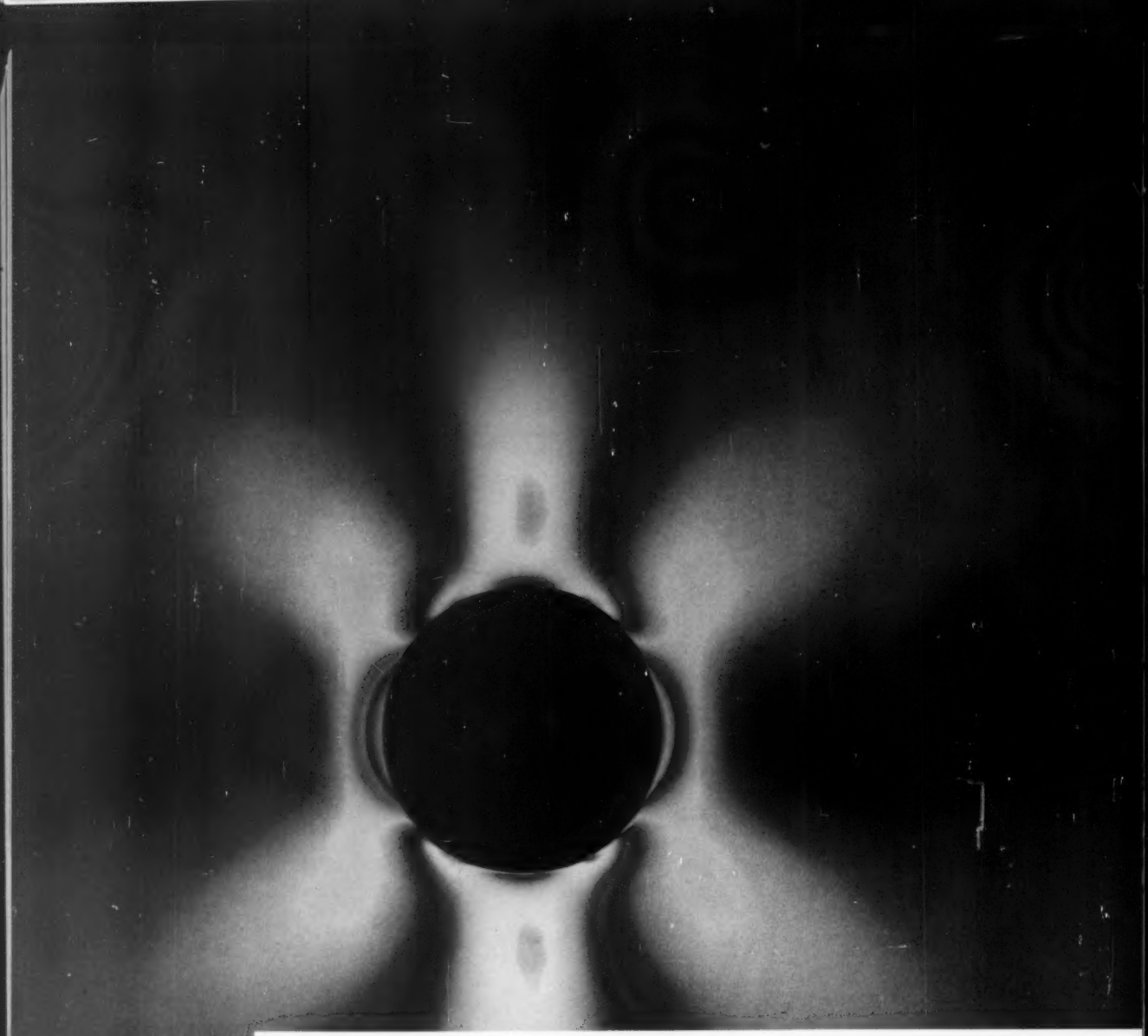


Photo-elastic stress patterns produced by models photographed with polarized light are one of the modern analytic tools available for ever-increasing perfection of Malleable iron castings.

Strength is Malleable

The strength crucial in spiraling the heave of diesels' pistons into unresistible power, in protecting lives as automobiles hurtle down endless highways, and in every link of chain that swings massive loads overhead, is yours to mold into tomorrow's dynamic engineering achievements with Malleable iron castings. Yet Malleable provides this strength in combination with toughness, producibility and economy that makes Malleable castings the finest, most versatile metal available.

For information or service, call on one of the progressive firms that identify themselves with this symbol—

MEMBER
MALLEABLE
CASTINGS COUNCIL

If you wish, you may inquire direct to the Malleable Castings Council, 1800 Union Commerce Building, Cleveland 14, Ohio, for information.

How to Get More Strength Per Dollar with Malleable Castings

With few exceptions, strength is the most important single design requirement for a metal part. But in the commercial production of that part, the ultimate objective is to manufacture it at the lowest possible cost. Malleable iron castings take advantage of many factors to provide the greatest strength per dollar of any ferrous or non-ferrous metal.

Great Strength Range Available

From the wide range of standard (ferritic) and pearlitic Malleable irons available, a type may be selected that meets strength requirements ranging from 50,000 p. s. i. to 120,000 p. s. i. tensile.

Table No. 1 shows these strength values and other physical measures for 9 grades of Malleable. Note particularly how high yield strengths are in comparison to tensile strengths. Because yield strength is generally the measure of usable strength, this is especially important.

Also important is the uniformity of Malleable's strength. The heat treatment given all Malleable castings produces a unique metallurgical combination of strength, ductility, machinability and impact resistance. At the same time, it relieves internal stresses so that Malleable's strength cannot be machined away, nor will it be present in some parts but missing in others.

TABLE No. 1
TENSILE PROPERTIES—
A.S.T.M. MINIMUM SPECIFICATIONS

Standard and Pearlitic Malleable Irons

Designation	Tensile Strength p. s. i.	Yield Strength p. s. i.	Ratio of Tensile to Yield %
Standard			
35018	53,000	35,000	66
32510	50,000	32,500	65
Pearlitic			
45010	65,000	45,000	69
45007	68,000	45,000	66
48004	70,000	48,000	69
50007	75,000	50,000	67
53004	80,000	53,000	66
60003	80,000	60,000	75
80002	100,000	80,000	80

Strengths up to 135,000 p.s.i. tensile and 110,000 p.s.i. yield are produced commercially under individual producers' specifications.

Economy Due to Multiple Factors

Malleable's superior strength-cost ratio is due to a combination of the casting process, which puts the metal where you want it, and the inherent economy of Malleable iron. Also, whenever machining operations are involved, Malleable castings cut finished costs significantly. Being the most easily machined of all ferrous metals of similar hardness, the cost of the finished part can often be reduced to less than that of metals which cost less in the semi-finished stage.

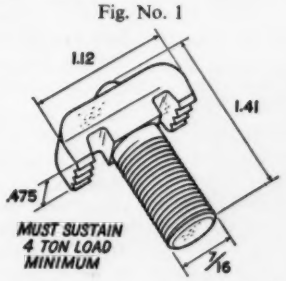
Malleable Provides Strength Plus Other Advantages

The T-bolt shown in Fig. 1 is used to assemble steel channel frames. Small but mighty, these 7/16″ bolts hold 4 ton loads. The tensile strength requirements are 90,000 to 100,000 p. s. i., yet ductility must be good and tolerances must be held to ±.005″ on the head width, and +.020″, —.000″ on the inside of the head.

In this application, pearlitic Malleable castings proved the only material consistently capable of sustaining loads over 8,000 pounds and meeting close tolerances in critical areas. At the same time, sufficient ductility was maintained to allow upsetting the spring retainer protrusion on the head.

The finished Malleable castings cost one third less than the next most satisfactory material. For both dynamic and static applications, today's Malleable castings are truly one of industry's finest engineering materials.

Fig. No. 1



Write for Free Data Unit

Data Unit 102-Strength, more fully describing Malleable's strength characteristics, is available for use by materials specifiers and users. For your copy, contact any member of the Malleable Castings Council or write to Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

These companies are members of the

MALLEABLE CASTINGS COUNCIL

CONNECTICUT
Connecticut Mall. Castings Co., New Haven 6
Eastern Malleable Iron Co., Naugatuck
New Haven Malleable Iron Co., New Haven 4

DELAWARE
Eastern Malleable Iron Co., Wilmington 99

ILLINOIS
Central Fdry. Div., Gen. Motors, Danville
Chicago Malleable Castings Co., Chicago 43
Moline Malleable Iron Co., St. Charles
National Mall. and Steel Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
Wagner Castings Company, Decatur

INDIANA
Link-Belt Company, Indianapolis 6
Muncie Malleable Foundry Co., Muncie
National Mall. & Steel Castings Co., Indianapolis 22
Terre Haute Mall. & Mfg. Corp., Terre Haute

MASSACHUSETTS
Belcher Malleable Iron Co., Easton

MICHIGAN
Albion Malleable Iron Co., Albion
Auto Specialties Mfg. Co., Saint Joseph
Cadillac Malleable Iron Co., Cadillac
Central Fdry. Div., Gen. Motors, Saginaw

MINNESOTA
Northern Malleable Iron Co., St. Paul 6

NEW HAMPSHIRE
Laconia Malleable Iron Co., Laconia

NEW JERSEY
Meeker Foundry Company, Newark 4

NEW YORK
Acme Steel & Mall. Iron Works, Buffalo 7
Frazer & Jones Company Division Eastern Malleable Iron Co., Solvay
Oriskany Malleable Iron Co., Inc., Oriskany
Westmoreland Mall. Iron Co., Westmoreland

OHIO
American Malleable Castings Co., Marion
Canton Malleable Iron Co., Canton 5
Central Fdry. Div., Gen. Motors, Defiance
Dayton Mall. Iron Co., Ironton Div., Ironton
Dayton Mall. Iron Co., Ohio Mall. Div., Columbus 16
Maumee Malleable Castings Co., Toledo 5
National Mall. and Steel Castings Co., Cleveland 6

PENNSYLVANIA
Buck Iron Company, Inc., Philadelphia 22
Erie Malleable Iron Co., Erie
Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries Company, Easton
Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

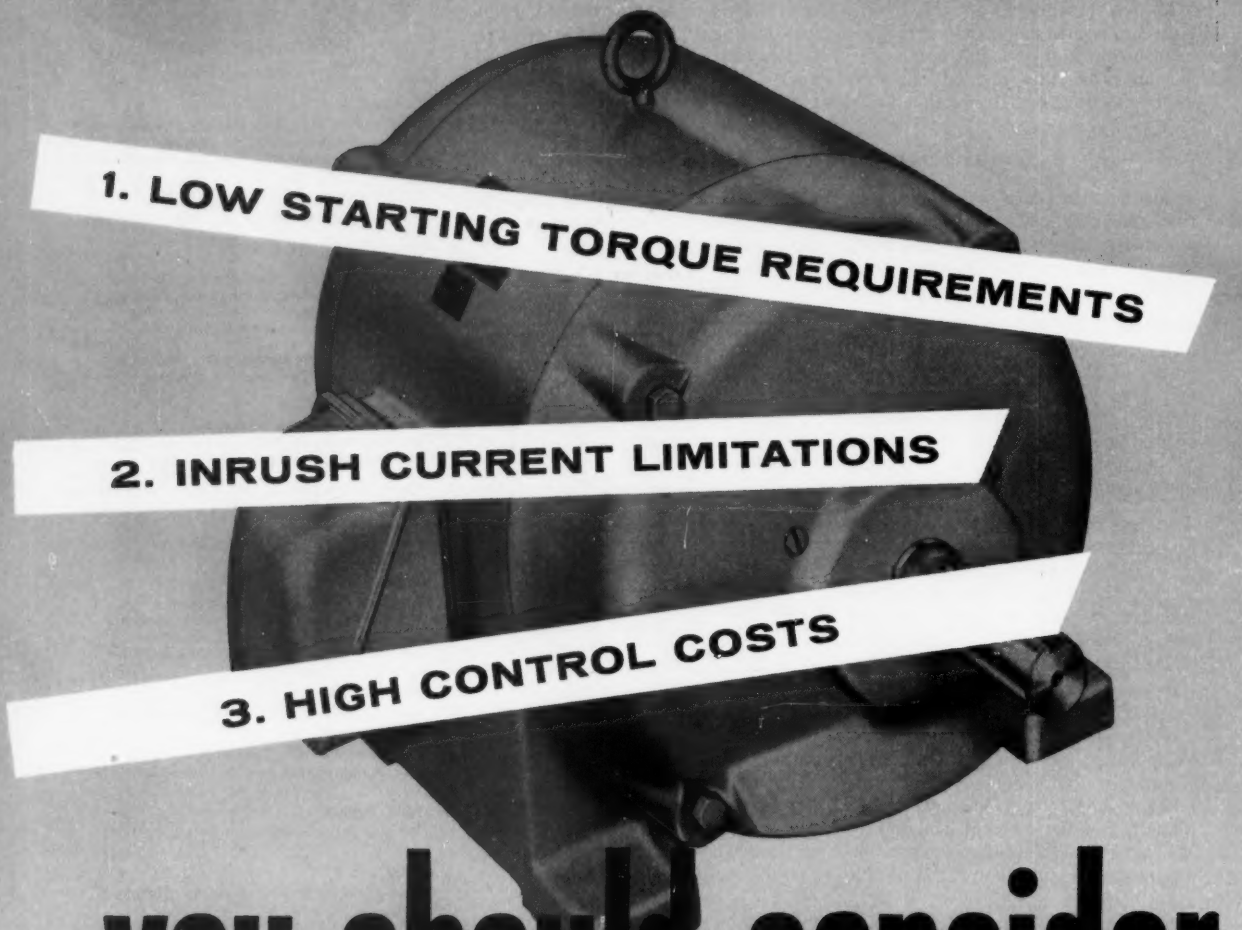
TEXAS
Texas Foundries, Inc., Lufkin

WEST VIRGINIA
West Virginia Mall. Iron Co., Point Pleasant

WISCONSIN
Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company Inc., West Allis 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works, Milwaukee 46

Circle 435 on Page 19

If you have this type of motor problem:



you should consider

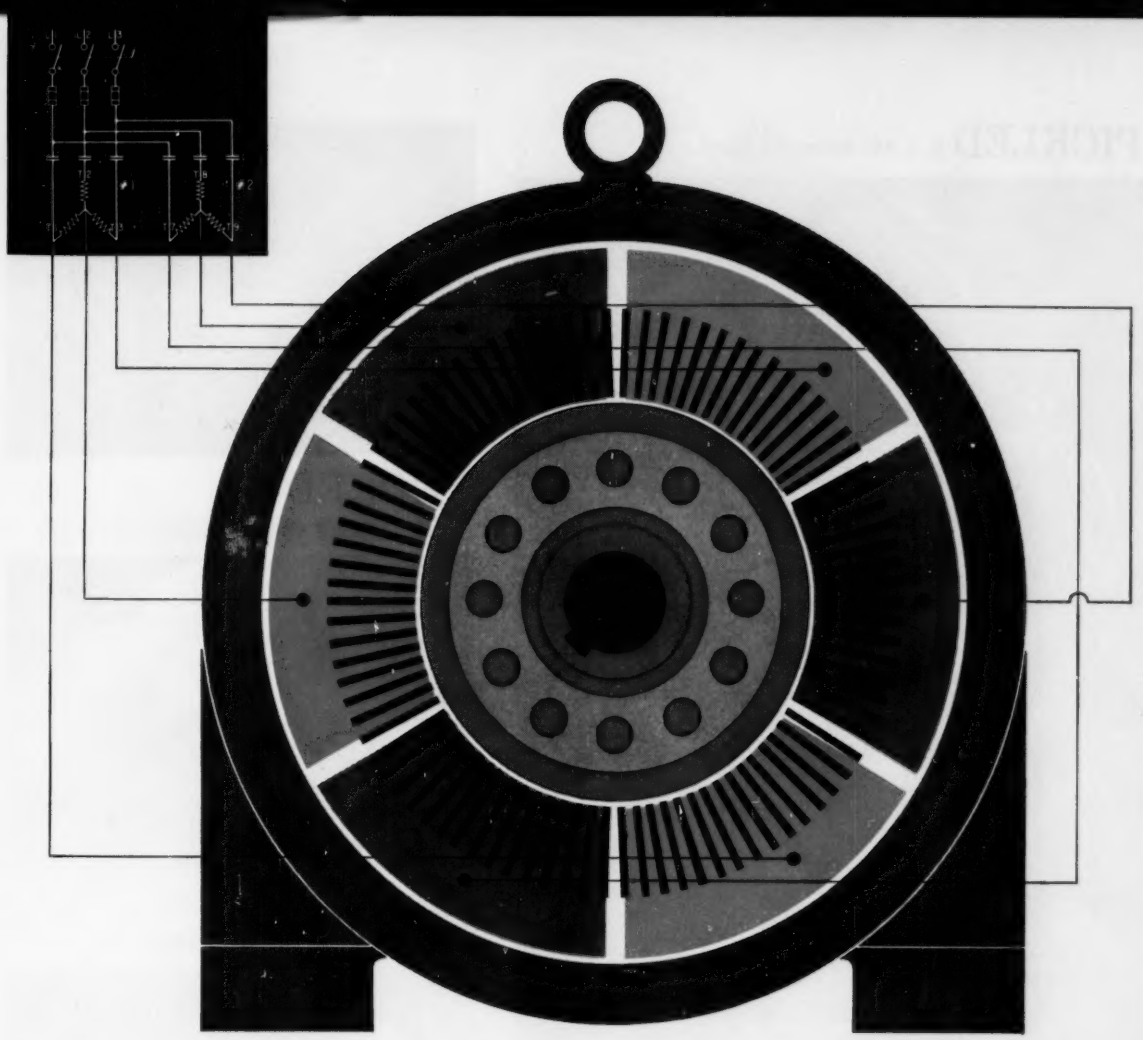
Why part-winding start? It's a question of large inrush current problems caused by *across-the-line starting* of motors that are getting bigger and bigger. Industry is concerned about the resulting voltage dips causing equipment to malfunction. Power companies are concerned about the attendant line-voltage fluctuations. And just as important, no resistors or auto-transformers are needed, making it the most economical of reduced KVA starting methods.

Why A. O. Smith? The answer is a scheme for part-winding start employing a *balanced*, two-section stator sequence. This allows the motor to be started at only three to four times the normal full-load running current — one set of stator windings usually brings motor up to running rpm in two to five seconds. Then, without breaking the circuit, the second set of windings cuts in smoothly and efficiently with minimum line disturbance.

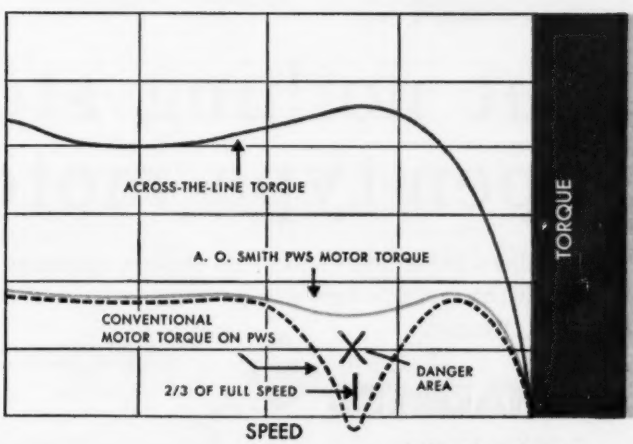
A. O. Smith's balanced start minimizes vibration and noise caused by unbalanced magnetic fields — a situation that often develops on conventionally wound motors. Electrically and mechanically balanced, A. O. Smith's PWS motor is quieter, smoother, longer lasting. A. O. Smith PWS vertical and horizontal motors are available from 15 hp to 150 hp.

Perhaps you have an application for this type motor. Why not let A. O. Smith's skill and experience in this particular field assist you? Write today for detailed information.

A. O. Smith offers a full line of motors—1/3 to 800 hp



part-winding start



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ELECTRIC MOTORS
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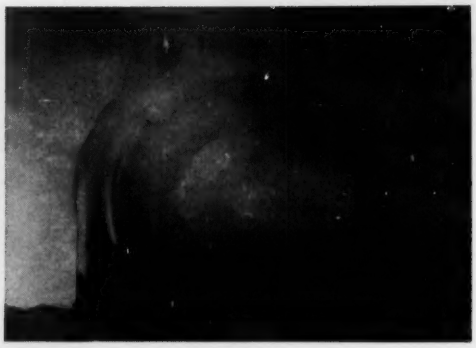
Circle 436 on Page 19

PICKLED in a 4% brine solution!



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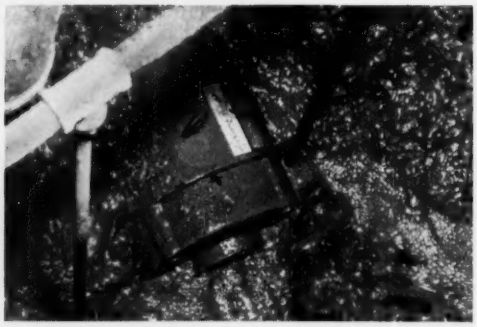
in a tornado of abrasive dust!

FROZEN
for weeks at 75° C below zero!



BURIED ALIVE
in thick, sluggish mud!

nothing . . . but nothing stops Super-Seal open-type motors

Thanks to exclusive Poxeal and Silco-Flex insulations, Super-Seal motors have shown endurances that even enclosed motors couldn't match. Results and reasons available from your A-C representative or distributor. Or write General Products Division, Milwaukee 1, Wisconsin

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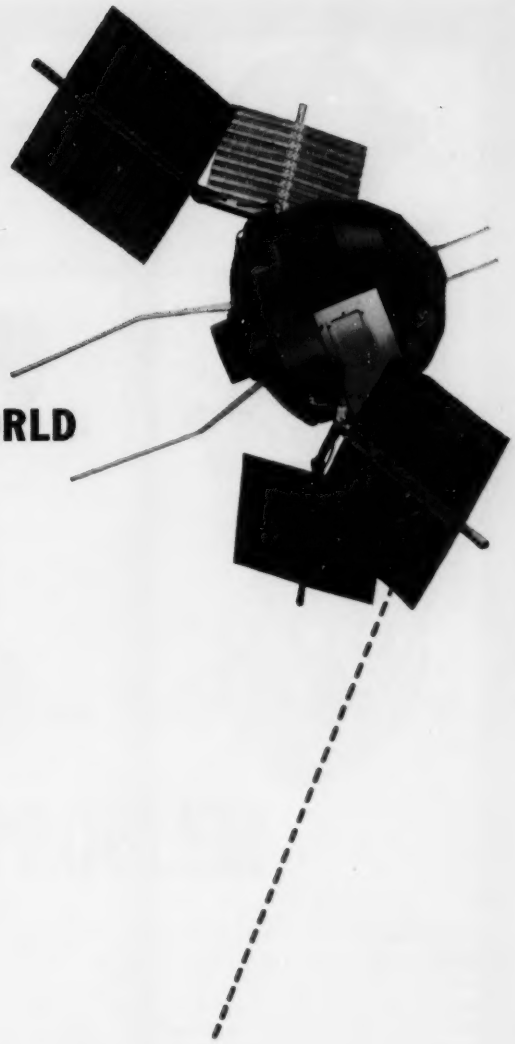
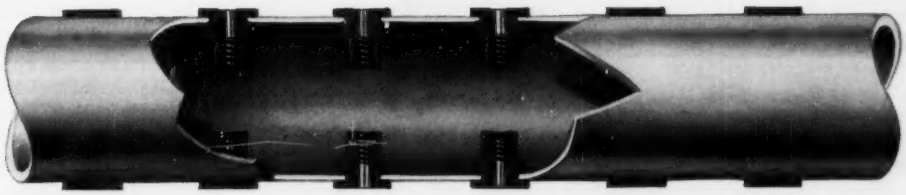


RIVNUTS® ARE OUT OF THIS WORLD



We've heard people say B. F. Goodrich Rivnuts are "out of this world." But now it's an established fact. They're in orbit on the Explorer VI "Paddlewheel" satellite, made by Space Technology Laboratories, Inc.

Upset inside the satellite's tubular spars (see cross section), Rivnuts provide solid nutplates for attaching the energy-producing solar cells. Rivnuts were chosen for use here because they are very light in weight and easy to install in blind tubular forms.

Rivnuts, the original blind fasteners with internal threads, come in a variety of types and sizes. You can now specify Rivnuts on your drawings by using N.A.S. numbers as shown on new N.A.S. drawings 1329 and 1330. Chances are there's a Rivnut that can help you simplify product design, speed assembly or cut costs in your manufacturing operation.

For a free copy of the Rivnut Data Book, write *B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Dept. MD-129, Akron, Ohio.*

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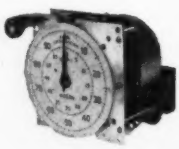
Circle 438 on Page 19

Miniature Might. Tiny Oyster Drills (*Urosalpinx Cinarea*) are noted destroyers of their much larger fellow-mollusks — oysters. One of 80,000 mollusk species, the Oyster Drill feeds on his victims through a shell-piercing snorkel.



Maximum Precision for the entire mechanism of this electric timer is assured by MPB bearings mounted on shaft ends and in gear trains. By reducing torque, these stainless steel bearings mean longer life and less maintenance for the timer.

Man with Miracles. Sales Manager Ken Broman heads MPB Sales Engineers in their engineering and consultative service to industry. One of these highly experienced MPB technical men is always ready to help solve your miniaturization problems.

More Miracles in Miniaturization

ACTUAL SIZE OF BEARINGS USED IN ELECTRIC TIMER SHOWN ABOVE

Designing and redesigning to meet modern requirements calls for miniaturization on a grand scale. Components for aircraft or outer space missiles must be reduced to minimum size and weight. Greater precision is needed in complicated, compact mechanisms and expert miniaturization is sought throughout industry. MPB helps you perform miracles in miniaturization by producing over 500 types and sizes of bearings ranging from 3/8″ O.D. down to 1/10″ O.D., with specials as required. For an illustrated catalog containing complete facts on these bearings, for engineering advice or both, write **Miniature Precision Bearings, Inc.,** 112 Precision Park, Keene, N. H.

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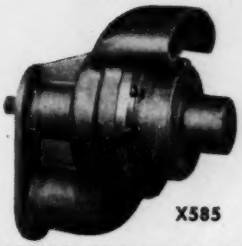
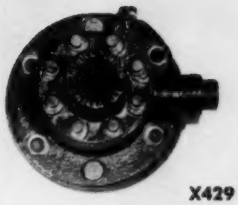
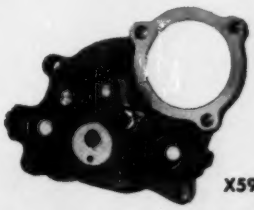
Circle 439 on Page 19

X250


X585


X429

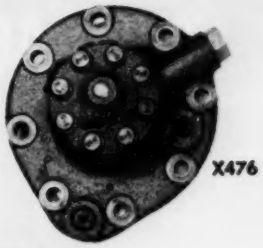
LDK


X597

for those special applications . . .

TUTHILL fits the pump to the PROBLEM

X543


X476

Here you see seven pumps . . . each designed to provide the best possible answer to one specific problem. They are typical of the many special application pumps developed each year at Tuthill.

For, while Tuthill offers over 800 standard models, often a customer's particular requirements indicate the desirability of special features not included in the standard line. For these applications Tuthill attempts to develop a pump to fit the problem . . . not require the user to modify his problem to fit a standard line.

Special housings

The seven examples shown indicate Tuthill's versatility in developing special housings for different types of equipment. For example, number X250 above was designed to provide a pump for a hydraulic actuator on a machine tool. The most convenient place to install this pump was on the hydraulic column . . . so the special mounting shown was designed. Most of the other unusual shapes shown above were similarly devised for greater convenience and lower assembly costs in building a pump into a particular piece of equipment.

Special materials, shafts, gearings

This versatility of housings and mounting arrangements only begins to indicate Tuthill's ability to best meet the requirements of a given application. As another example, models number X543 and X585 have bronze outer construction, and other features which particularly qualify them for marine applications. Model X429 above incorporates Tuthill's special automatic reversing feature. This means the pump may be driven from a reversing shaft . . . or provides for applications where a machine must be shipped without knowing the ultimate direction of the driving unit.

Tuthill pumps may be supplied with a wide variety of shaft seals for use with various fluids. They can incorporate strainers, as model X585 above. They may be provided with, or without, built-in relief valves. They can incorporate a wide variety of special shaft modifications or gearing to accommodate various driving units.

They may be provided with steam jackets for use with viscous fluids. They may be also shipped as stripped models that can be built right into your equipment.

Tuthill's experienced application engineers will be happy to show you how Tuthill can develop a pump to fit the requirements of your particular application. Write today for a copy of catalog 100.

Tuthill manufactures a complete line of positive placement rotary pumps in capacities from 1 to 200 GPM; for pressures to 1500 PSI; speeds to 3600 RPM.

TUTHILL PUMP COMPANY

953 East 95th Street, Chicago 19, Illinois

Circle 440 on Page 19

YOU SHOULD TRY ELECTRUNITE

The welded hydraulic fluid line tubing that offers lower initial cost... appreciable savings in downtime

The reason... uniformity! ELECTRUNITE Hydraulic Fluid Line Tubing is made from *high-grade, close-tolerance, flat-rolled* steel. Checked for defects as only flat rolled steel can be checked. Then: carefully formed, welded, annealed, cold-worked, and annealed again into a tube of unsurpassed uniformity... a tube that is easier to bend, easier to flare... a tube that meets or exceeds the normal life of tubing produced by any other method.

All this plus the fact that ELECTRUNITE costs *less* to buy (in all sizes shown in the *JIC Standards Book* and in an even wider range of sizes produced to our specification HL-1). Savings in downtime reflect still greater cost reductions. In the history of ELECTRUNITE Hydraulic Fluid Line Tubing, no failure resulting from longitudinal or transverse cracks has been reported.

The big switch is on! Join the hundreds of equipment and machinery builders and their maintenance departments now using millions of feet of ELECTRUNITE Hydraulic Fluid Line Tubing. Mail the coupon for complete information, including a copy of specifications.

MEETS ALL REQUIREMENTS OF THE JIC STANDARD!

ELECTRUNITE® is available in all sizes shown in JIC Standards Book. Available in a wider range of sizes produced to our specification HL-1 (which meets all test requirements of the JIC standard).

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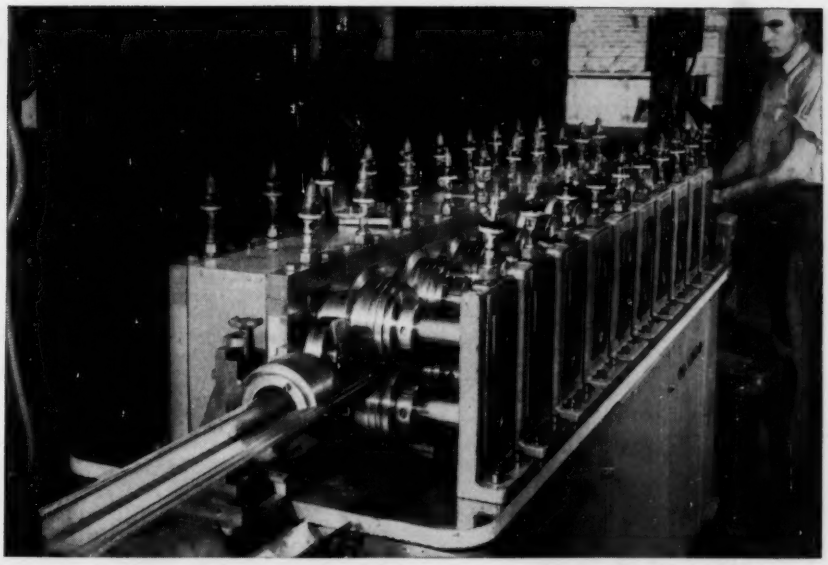
SAVE PAINT PREPARATION COSTS on your formed steel products by specifying Republic Electro Paintlok®. Special paint-holding surface applied at our mills won't crack, flake, or peel—even under severe bending—as demonstrated by this acoustical panel forming operation. Final finish can be applied immediately, with excellent results. Mail coupon for complete information.

Circle 498 on Page 19



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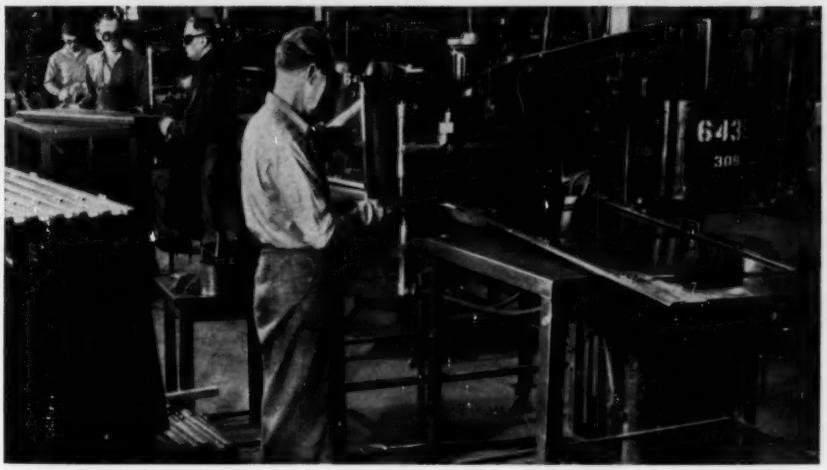
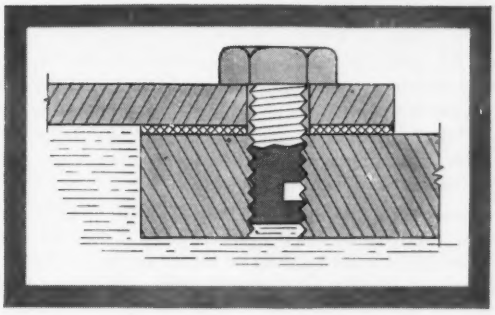
Circle 499 on Page 19





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Circle 500 on Page 19

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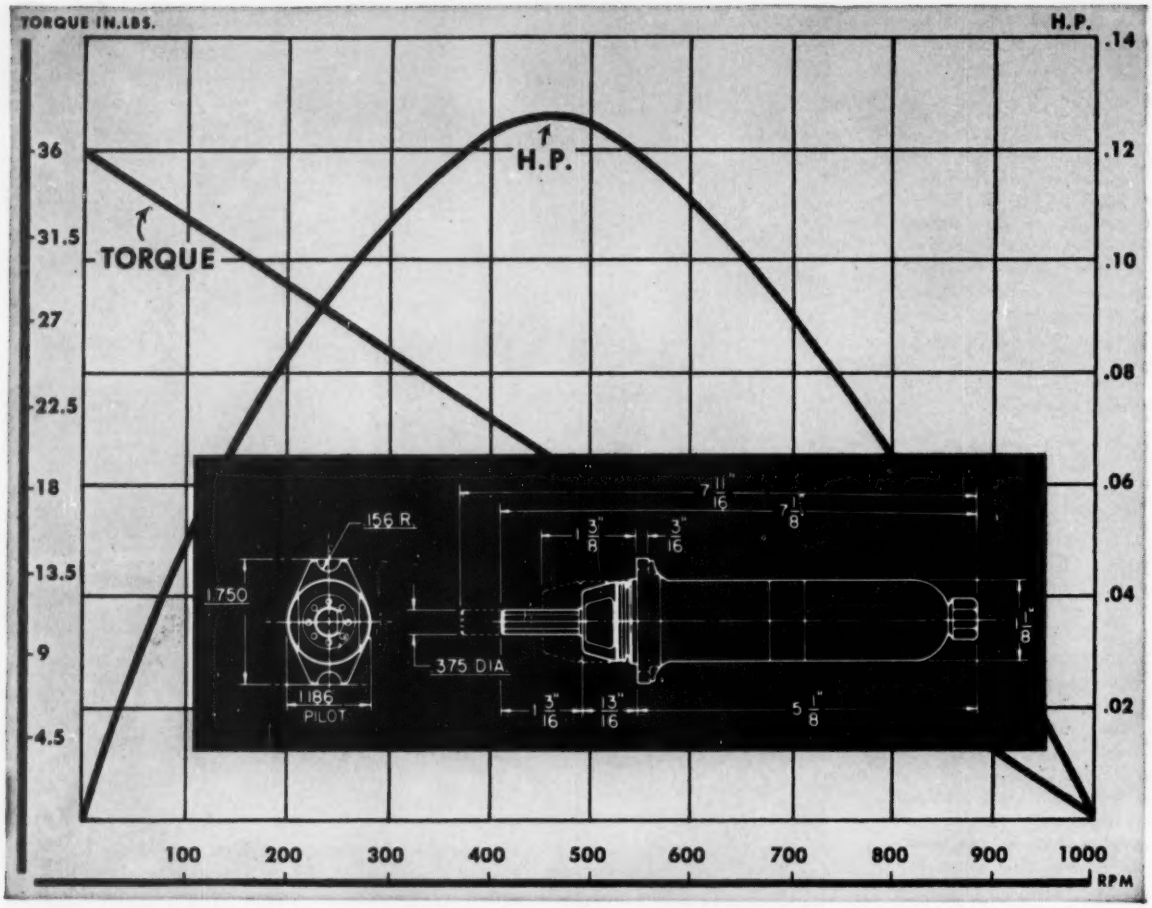

Power curve for this air motor shows 36-in.-lb. torque at low speed . . . max. power development of ⅛ hp.

Compact rotary air motor packs ⅛ hp in 1⅛″ diameter

WHEREVER IN THE WORLD

the products you design are put to work, your customers will find a convenient Gardner-Denver office with ample parts stocks on hand, and manned by factory-trained service specialists. At Gardner-Denver there's no substitute for men—our 100-year philosophy of growth.

Here's a compact, fractional hp rotary vane air motor, designed by Gardner-Denver for small hp needs that require heavy-duty service.

Ideally suited for close quarters and portable applications, it weighs less than a pound . . . develops ⅛ hp with stall torque up to 36 in.-lb. . . . measures only 7⅛″ long x 1⅛″ body diameter.

This Gardner-Denver air motor also offers variable speed-torque control . . . positive, instantaneous response . . . continuous operation . . . no spark hazard . . . can't burn out.

Three basic speeds are available: 20,000, 5000 and 1000 rpm. Simple plate-mounting with two cap screws makes it easy to adapt the motor to any setup. It's designed to be flange-mounted, locating from a 1 3/16″ diameter pilot and clamped with two ¼″ screws. Either continuous or intermittent-duty applications are practical.

Other rotary air motors are available in sizes up to 1.5 hp, with piston motors available to 16 hp. Put air power to work in *your* design. Contact your nearby Gardner-Denver representative for complete information or write for Bulletin 71-21.

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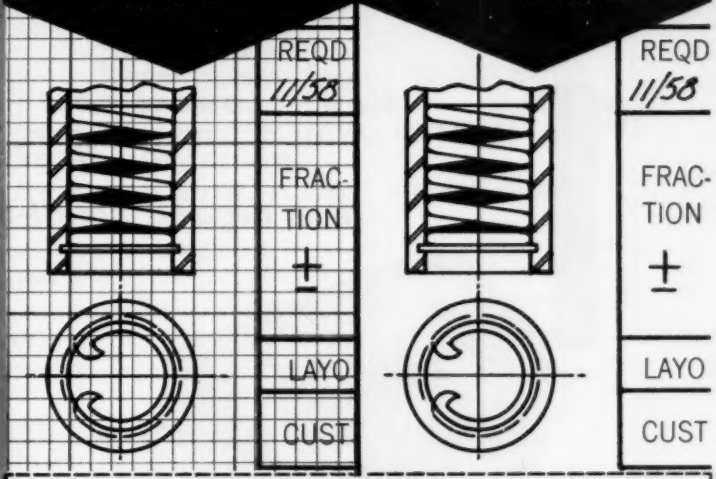

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A new triumph in small-motor design! In almost every case this powerful new induction motor will *cost less, perform better* . . . than any comparable motor you are now using, or can buy elsewhere! Available in hysteresis synchronous, permanent split capacitor, split phase and capacitor start models with 4 pole ratings from 15 milli-horsepower to 1/20 h.p. Mounting and performance characteristics can be designed to your particular application requirements. Be sure to check with us on this outstanding new induction motor achievement.

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2

5 Year Guarantee on this new low cost, patented* Unit Bearing Motor!

Model 1085 —
2 pole, unit bearing—1/750 to 1/185 h.p. No load RPM: 3400; Full load RPM: 2600-3200 or lower

Ideal for Fan, Pump, Gear Box and many other Applications... Now used by leading manufacturers for Frost-proof refrigeration

FIRST LOW COST UNIT WITH PRECISION BEARINGS • NEEDS NO OILING • TESTED FOR PERFORMANCE FROM −10° TO 250°F.

This exceptionally economical new unit bearing motor has a patented bearing construction that assures long, unattended life. It is fully guaranteed for 5 years—with a life expectancy of 10 years of continuous duty as shown by rigid lab tests. Available for a wide range of ambients, with skeleton frame or housed construction . . . tailored to suit your individual mounting requirements. Now being widely used to circulate air for frost-proofing refrigerator units. Lowest prices in the field—find out for yourself!

*Pat. No. 2,904,709

H.P. motor developments:

3

Motor Parts Sets cost less than ever with Howard's new, modern, semi-automated production facilities!

Cut costs on every product that uses individual motor parts with Howard's *complete*, quality-built and low priced line! Sets include armatures and fields, brushes and brushholders, rotors, stators and fans—in any combination as needed. If parts sets are your concern, let us show you our truly *competitive* line!

HOWARD INDUSTRIES, INC., 1735 STATE ST., RACINE, WIS., Telephone ME 2-2731, Teletype: RAC344

HOWARD INDUSTRIES, INC., 1735 STATE ST., RACINE, WIS.

Please send me complete information on:

☐ NEW 3" INDUCTION MOTOR ☐ NEW UNIT BEARING MOTOR
☐ MOTOR PARTS SETS ☐ PLEASE HAVE A HOWARD REPRESENTATIVE CALL ON ME ☐ PLEASE SEND ME A FREE HOWARD CATALOG

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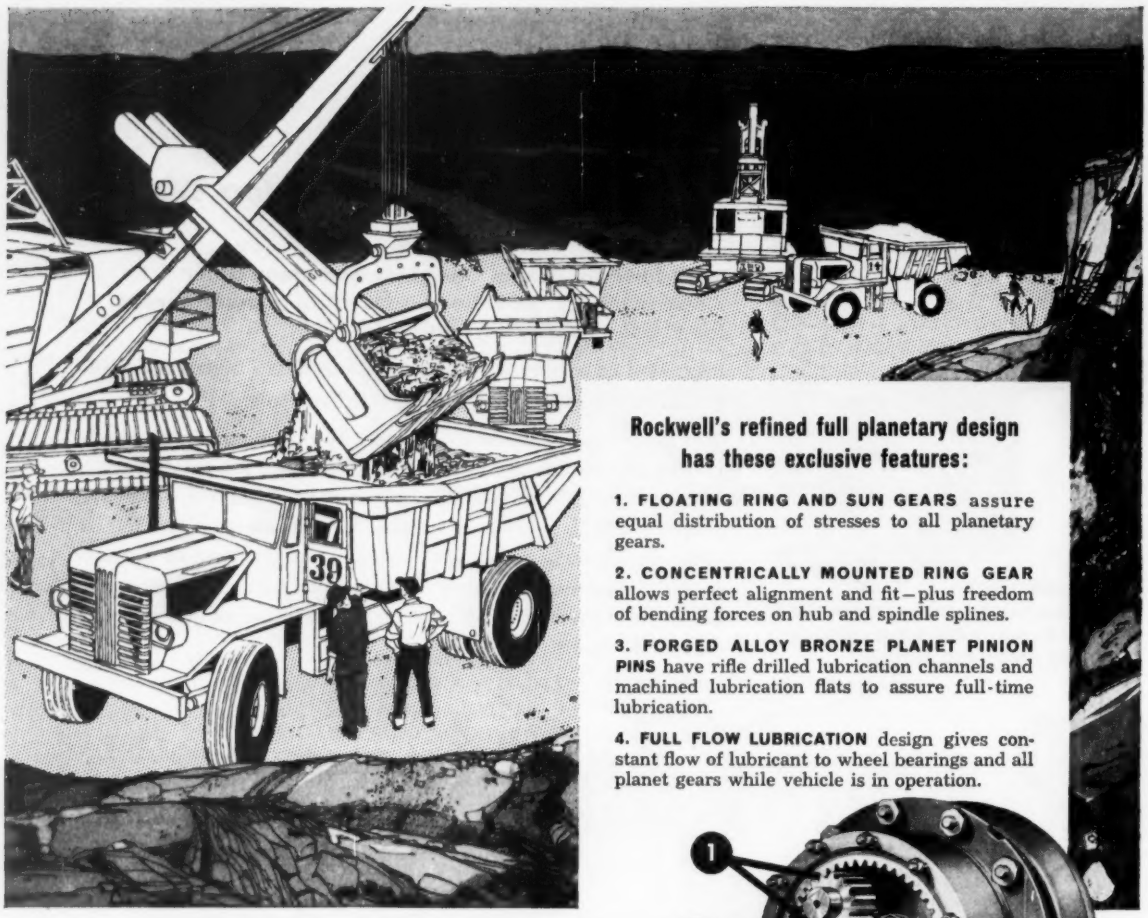
ELECTRIC MOTOR CORPORATION
CYCLOHM MOTOR CORPORATION
RACINE ELECTRIC PRODUCTS
LOYD SCRUGGS COMPANY

Circle 444 on Page 19



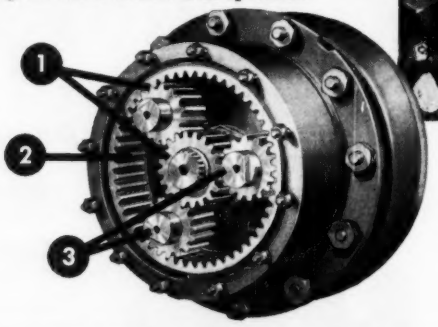
Rockwell's refined full planetary design has these exclusive features:

1. **FLOATING RING AND SUN GEARS** assure equal distribution of stresses to all planetary gears.

2. **CONCENTRICALLY MOUNTED RING GEAR** allows perfect alignment and fit—plus freedom of bending forces on hub and spindle splines.

3. **FORGED ALLOY BRONZE PLANET PINION PINS** have rifle drilled lubrication channels and machined lubrication flats to assure full-time lubrication.

4. **FULL FLOW LUBRICATION** design gives constant flow of lubricant to wheel bearings and all planet gears while vehicle is in operation.



"TIMKEN-DETROIT® PLANETARY AXLES

BEST DRIVE FOR THE HEAVYWEIGHTS!"

Here's new rugged dependability for prime movers, four-wheel tractors, heavy off-road wagons, mining and agricultural equipment, and many other heavy-duty applications. Rockwell-Standard's complete line of planetary axles are available in capacities up to 150,000 pounds. And to meet every job need, there is a planetary steering axle operationally matched to each rigid planetary in the line.

The large reductions possible with Rockwell's full planetary, double-reduction axles enable them to ideally perform most heavy-duty off-highway operations. Because the substantial planetary reduction is located in the wheel hub, axle shafts and first reduction gears carry only nominal torsional loads—give long trouble-free service. For the best heavyweight drive, specify Timken-Detroit.

Another Product of...

ROCKWELL-STANDARD CORPORATION

ROCKWELL R STANDARD ®

Transmission and Axle Division, Detroit 32, Michigan

Circle 445 on Page 19

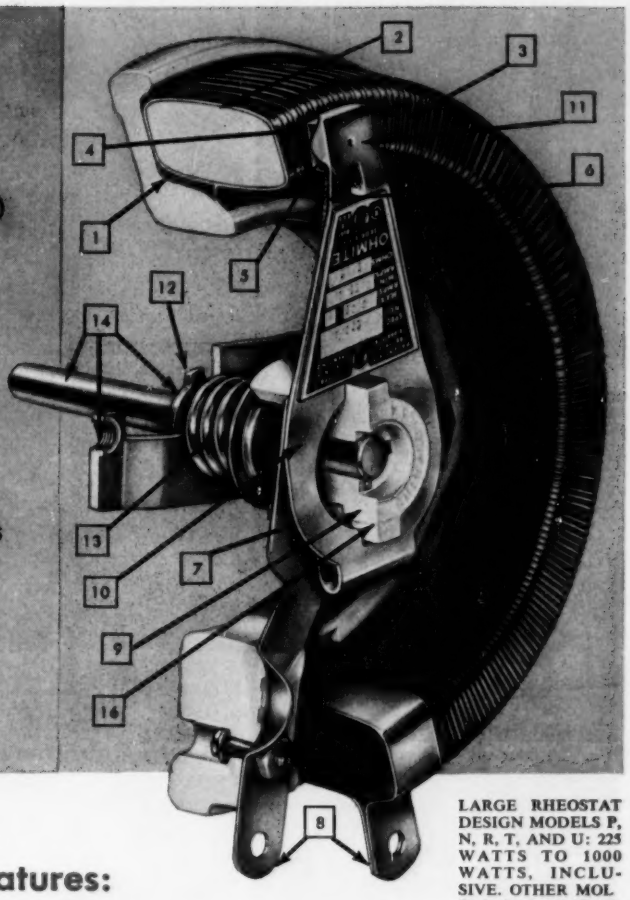
Smooth Close Control

OHMITE®

RHEOSTATS

NOW 11 Sizes! 12½ to 1000 Watts

Ohmite offers you industry's most complete line of rheostats. All sizes are available from stock in a wide range of resistance values, including the NEW Model "E." Ten sizes are available to meet MIL-R-22A requirements in *each* of the 26 type designations.



LARGE RHEOSTAT DESIGN MODELS P, N, R, T, AND U: 225 WATTS TO 1000 WATTS, INCLUSIVE. OTHER MODELS ARE SIMILAR.

16 Quality Engineering Features:

1. Vitreous enamel bonds the core and base together into one integral unit.
2. The wire is wound over a solid porcelain core, and each turn is locked against shifting by vitreous enamel. Uniform or tapered winding.
3. Close graduation of control. Each turn of wire is a separate resistance step.
4. Large, flat surface upon which the contact brush rides.
5. Metal-graphite contact brush (varied to fit current and resistance) insures good contact, with negligible wear on the resistance wire.
6. Shunt pigtail of ample size carries the current directly to the slip-ring.
7. Large slip-ring of high-current carrying ability minimizes mechanical wear and provides connection from the moving contact to the terminal.
8. Potentiometer use. The rheostats are provided with three terminals so they can be used as potentiometers or voltage dividers.
9. High strength ceramic hub insulates the shaft and bushings from all live parts. All sizes will stand a 3000 volt a-c breakdown test to ground.
10. The contact arm is a long tempered steel spring which assures uniform contact pressure at all times. Cadmium-plated for corrosion resistance.
11. Rounded pivot holds contact brush in flush-floating contact with wire.
12. Stops which are keyed to the shaft and base limit the rotation—thus no torsional strain is imposed on the contact arm on stopping.
13. Compression spring maintains uniform pressure and electrical contact between slip-ring and center lead at all times.
14. Models E, H, J, G, K, and L: End-thrust is taken by a retaining ring. Models P, N, R, T, and U: End-thrust is taken by a stop washer. Steel shaft in brass bushing provides a wear-resistant, wobble-free bearing.
15. Ohmite rheostats meet requirements of NEMA and EIA (formerly RETMA).
16. There are only ceramic and metal in the construction of Ohmite rheostats—there is nothing to char, burn, shrink, or deteriorate.

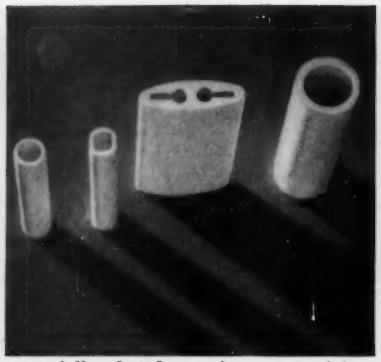
Write on company letterhead for Catalog 58.

BE RIGHT WITH OHMITE® QUALITY Components

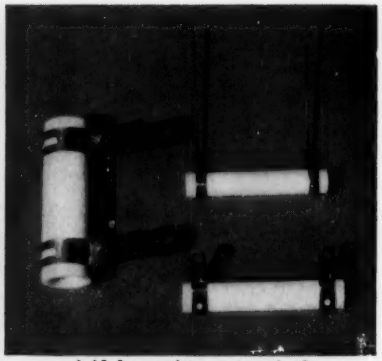
OHMITE MANUFACTURING COMPANY
3618 Howard Street Skokie, Illinois

RHEOSTATS RESISTORS RELAYS
TAP SWITCHES TANTALUM CAPACITORS
R. F. CHOKES VARIABLE TRANSFORMERS

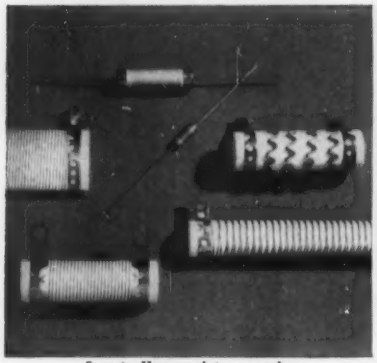
tough tests for incoming material



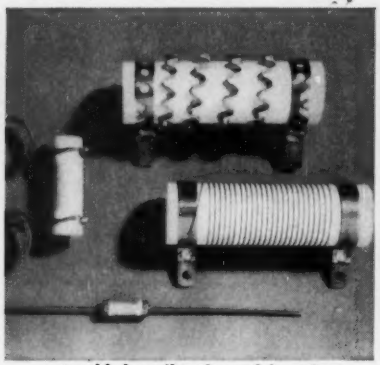
specially selected ceramic core materials



rigid, low resistance terminals

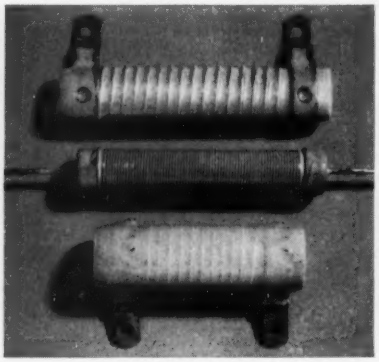


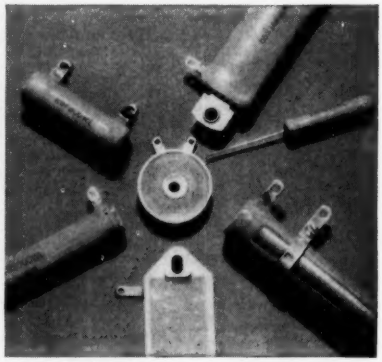
finest alloy resistance wire



spot welded or silver brazed junctions

THIS IS A **RESISTOR** YOU CAN STAKE YOUR REPUTATION ON





our own VITROHM enamel, first coat . . . and final coat

Built-in VITROHM reliability, from core to final vitreous enamel, lets you solder these resistors in and forget 'em

They come in a tremendous variety of sizes, shapes and ratings, but all Ward Leonard VITROHM resistors have one thing in common: They're built for maximum reliability.

Take just one point—ceramic cores, for example: Made by Ward Leonard to exacting specs, the cores feature low-porosity, high-dielectric-strength ceramic for maximum moisture exclusion and good electrical insulation. What's more, the thermal coefficient of linear expansion of ceramic is specially selected to make the core compatible with resistance wire, enamel and terminals . . . to prevent cracking, crazing, peeling, or layer separation.

And there's the same meticulous care with all the other elements that go to make up a finished VITROHM resistor: terminals, spot welded or brazed junctions, resistance wire, and last but not least, W/L VITROHM enamel, formulated and manufactured in our own modern enamel smelting plant . . . provides complete electrical and mechanical protection.

To insure reliability in your product . . . specify VITROHM's. Write for data packed catalog #15, and list of stocking Electronic Distributors: Ward Leonard Electric Co., 58 South Street, Mount Vernon, N.Y. (In Canada: Ward Leonard of Canada Ltd., Toronto.) 9.4

WARD LEONARD
ELECTRIC COMPANY
MOUNT VERNON, NEW YORK

LIVE BETTER...*Electrically*

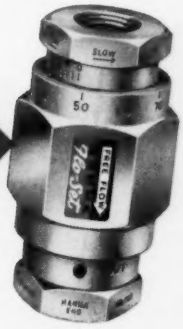
Result-Engineered Controls Since 1892

RESISTORS | RHEOSTATS | RELAYS | CONTROLS | DIMMERS

. . . MICROMETER SETTING

For Exacting Flow Control

HANNA *Flo-Set* VALVES



Hydraulic pressure to 1000 psi
Sizes ¼", ⅜", ½", ¾"
Temperatures to 250°F

Air, Oil, water operation to 250 psi
Sizes ¼", ⅜", ½", ¾"
Temperatures to 250°F

OTHER HANNA VALVES
include solenoid, pilot, hand and foot operated types

FOR AIR • OIL • WATER • OTHER FLUIDS

REGULATING cylinder speeds or controlling fluid flow of air, oil or water is so simple with Hanna Flo-Set Valves . . . you need only turn the valve body one revolution to adjust from zero to full pipe capacity. Micrometer-type graduations are numbered to indicate the percentage of pipe capacity. Once set, the position can be locked to avoid accidental change. Future resetting to a predetermined flow requires no guesswork.

Hanna Flo-Set Valves allow full flow in one direction—controlled flow in the opposite. Used in pairs, they regulate independently cylinder instroke and outstroke speeds. Hanna Flo-Set Valves assure uniform speed, smoother action and improved performance of cushioned and non-cushioned cylinders.

Valve sizes are ¼", ⅜", ½", and ¾" . . . a ¼" Jr. model, without graduations or locking collar, is available for light piping and tubing.

Whatever your problem of precision fluid control may be—you will find the best answer in Hanna Flo-Set Valves—designed, built and guaranteed by Hanna's 50 years of experience in hydraulics and pneumatics.

WRITE FOR LITERATURE AND COMPLETE DETAILS, *or consult your classified telephone directory or Thomas' Register for your nearest Hanna representative.*

Hanna Engineering Works

HYDRAULIC AND PNEUMATIC EQUIPMENT . . . CYLINDERS . . . VALVES

1751 Elston Avenue • Chicago 22, Illinois

Circle 448 on Page 19

MODERN DROP-THROUGH METHOD SPEEDS DIE-CASTING PRODUCTION BY 50%

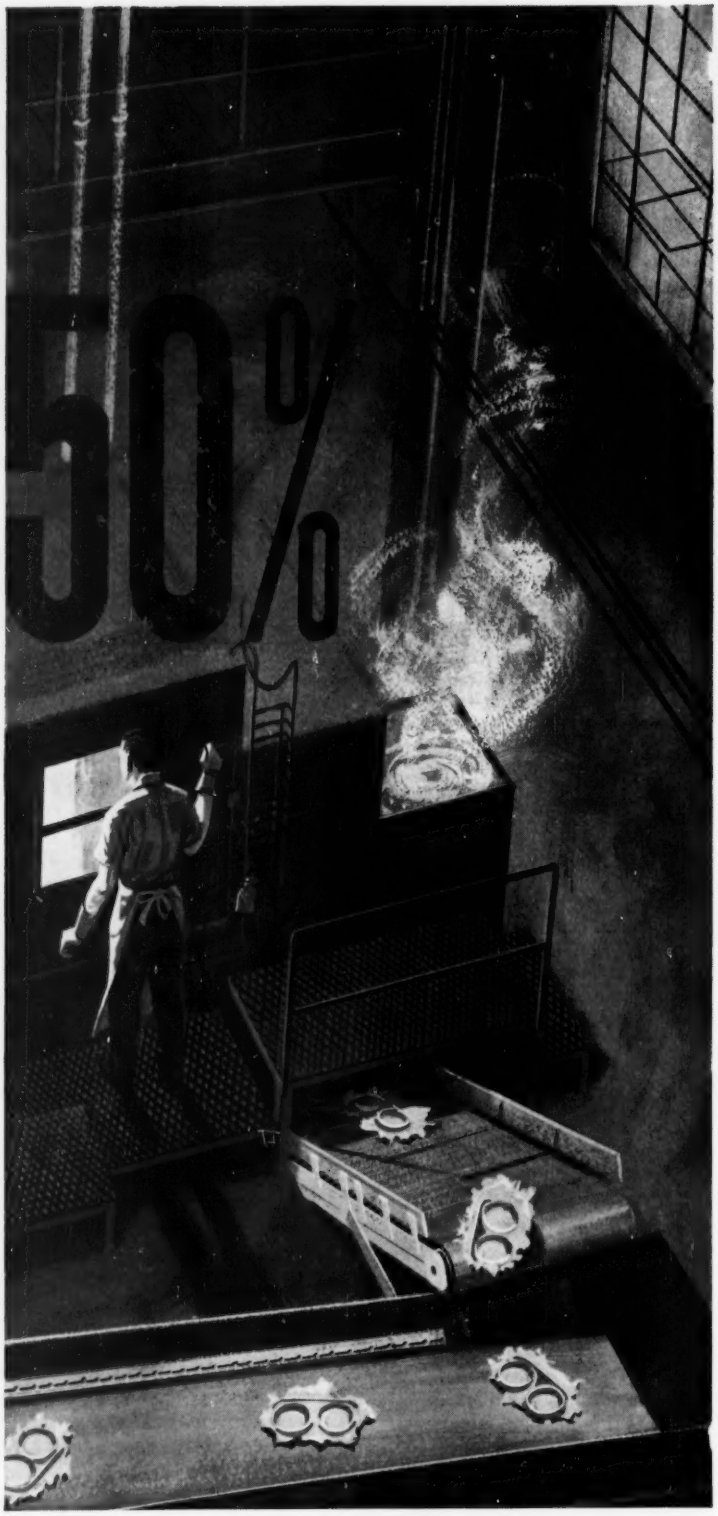
Brown-Lipe-Chapin eliminates manual handling with mechanical ejection of hot die castings.

Here's a typical example of how Brown-Lipe-Chapin engineers put quality into your die cast parts.

After the die casting cycle, castings are ejected automatically into a quench, where a conveyor takes them to the trim press. This modern method of die casting allows a maximum operating rate and boosts the over-all production rate by 50%. Also, casting uniformity is assured because the cycle time is constant and unaffected by operator fatigue or other human factors.

This is just one of the many outstanding features of Brown-Lipe-Chapin die casting facilities that can help make your product better and to more rigid quality standards.

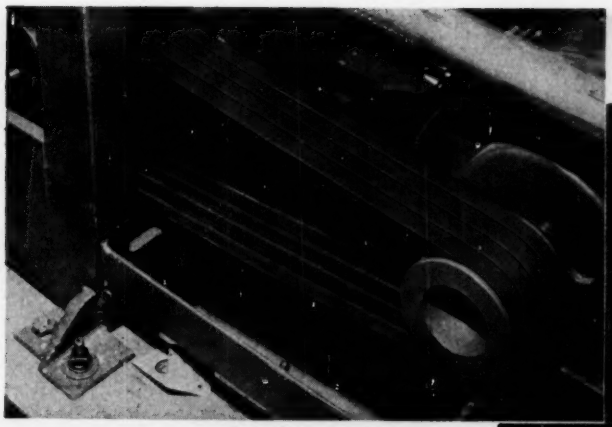
Under the same roof are facilities for metal stamping, anodizing, electroplating, buffing and polishing, precision painting, plus complete engineering service. And two Brown-Lipe-Chapin plants, strategically located in Elyria, Ohio and Syracuse, New York, offer the same complete facilities. For further information, call or write Brown-Lipe-Chapin, Syracuse, New York.

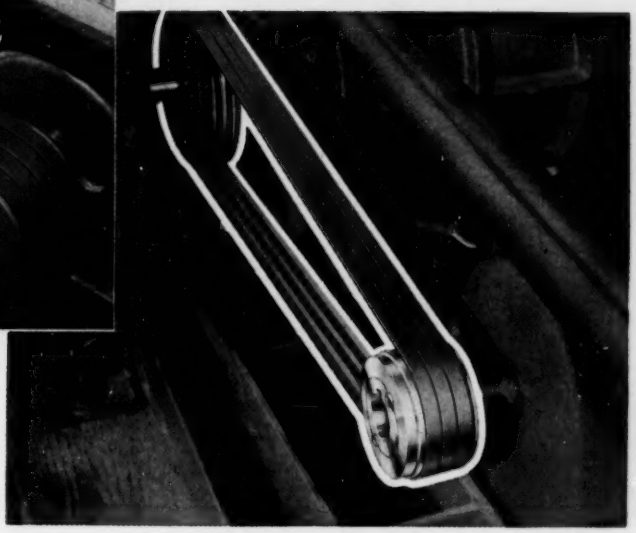


GM GENERAL MOTORS

RELIABILITY by BROWN·LIPE·CHAPIN

DIVISION OF GENERAL MOTORS CORPORATION





Before: Four standard belts were required to drive the clothes pressing unit manufactured by a Utah company.

After: Three Gates Super HC V-Belts now handle the redesigned pressing unit drive — save more than 16 pounds in drive weight — 24% in drive cost.

Utah manufacturer cuts drive cost 24% with new high capacity V-Belt

Drive weight reduced 16 pounds per unit!

This manufacturer is just one of many who have already turned to Gates Super HC V-Belts to achieve far more compact, lighter weight, lower cost V-belt drives for all types of machines. With new Super HC V-Belts, sheave dimensions can be reduced 30% to 50%, overall space up to 50%, and drive weight by 20% and more.

A product of Specialized Research in the world's largest V-belt laboratories at Gates, the Super HC V-Belt Drive is already standard equipment on production models in virtually every industry.

Engineering Service Nation-Wide

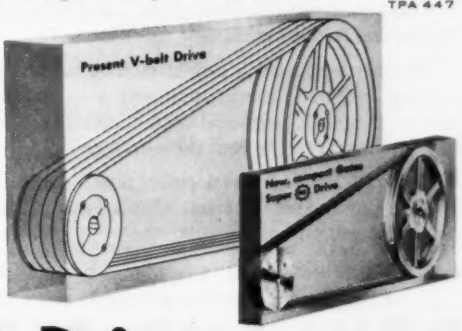
Whatever your plant's power transmission design problem, wherever you are, your nearby Gates Distributor or Field Representative is ready to assist you to cut space, weight, and costs with Super HC. Ask him for a copy of *"The Modern Way to Design Multiple V-Belt Drives."*

TPA 447

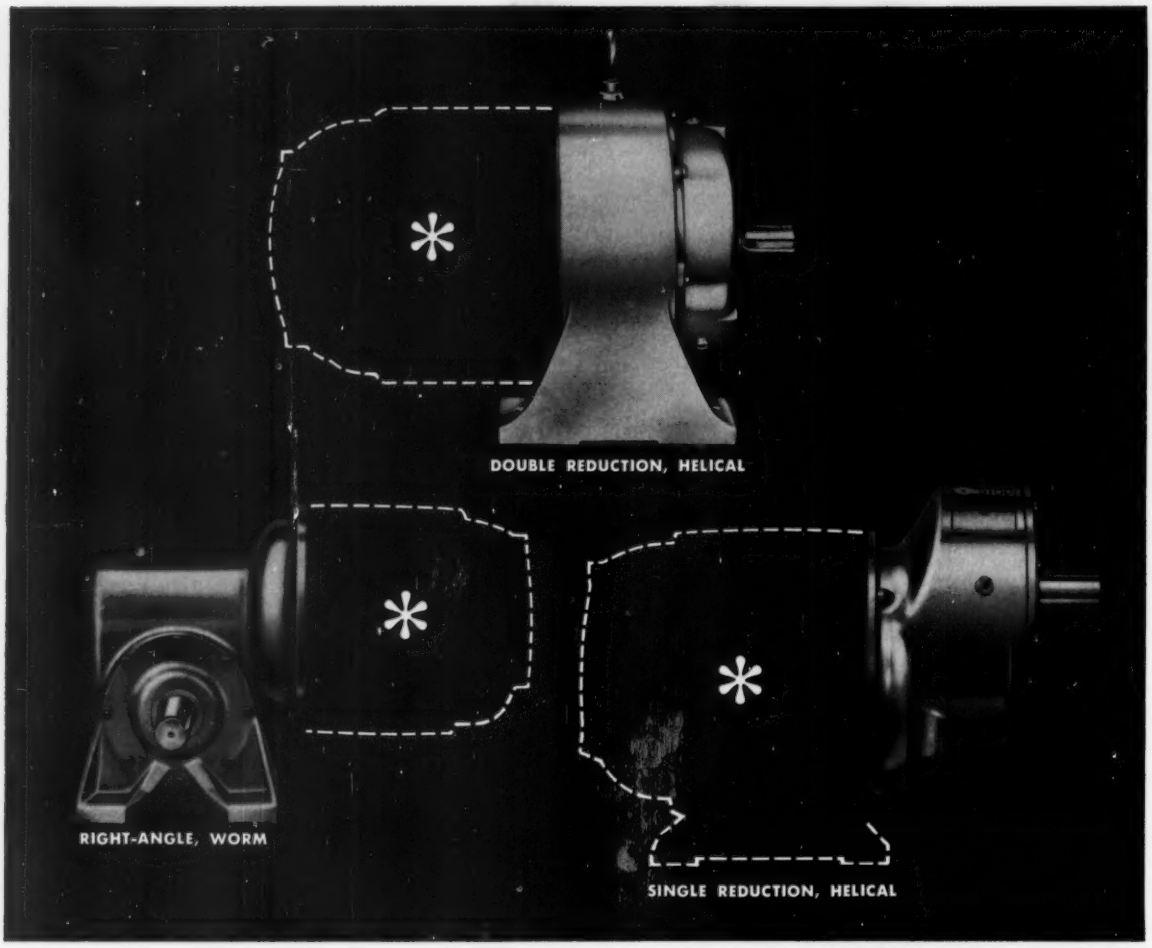
The Gates Rubber Company, Denver, Colorado
Gates Rubber of Canada Ltd., Brantford, Ontario

Gates

World's Largest Maker of V-Belts



Gates Super HC V-Belt Drives same hp capacity in smaller "package"



Need a Motoreducer with an unusual drive motor?

LET REULAND TAILOR A MOTOREDUCER PACKAGE TO YOUR EXACT NEEDS . . .

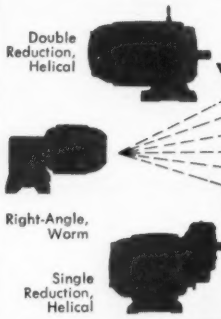
No longer must you "make something do" . . . no longer must you modify *your* machine to fit the *drive!* Hundreds of different speed and power variations can be developed from the three basic Reuland gear reduction units shown above.

This is made possible through the use of Reuland's famous "Xpandable-Design" idea.

Whether you need a simple motor-and-reducer – or an amazing, automatic combination with a special motor, gear reducer, magnetic brake and fluid coupling – Reuland engineers can quickly solve your drive problem.

Costs are lowered. Development time is saved. Your drive is *right*. Why not see first-hand what a Reuland Motoreducer can do for you.

*** ADD ANY ONE OF THESE 6 DRIVE MOTORS TO ANY OF THE 3 GEAR REDUCTION UNITS SHOWN ABOVE . . .**



1. Fluid-Shaft
2. Standard Squirrel Cage
3. Multi-Speed
4. Wound Rotor
5. Crane – Hoist duty motors
6. Torque motors

Our new brochure "Modern Power for Modern-Day Products" will be helpful in your work. Sent free on request.

MODERN POWER FOR MODERN-DAY PRODUCTS . . . ALL IN LIGHTWEIGHT ALUMINUM FRAMES!

REULAND MOTORS

Reuland Electric Company – Distributors in all principal cities

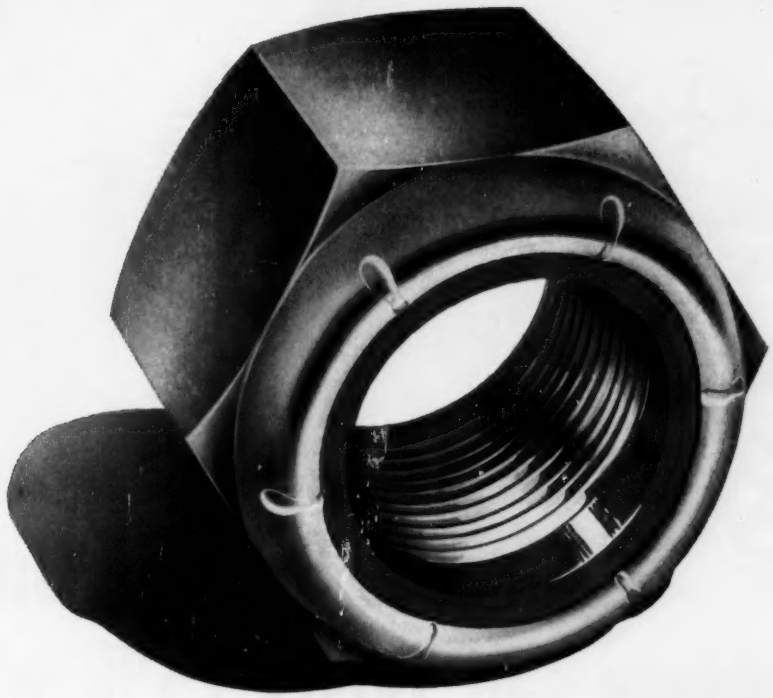
Western Division: Alhambra, California • **Eastern Division:** Howell, Michigan

A DEMONSTRATION UNIT FOR YOUR EQUIPMENT?

So sure are we you'll like what you see, we're offering to engineer a demonstration unit for your equipment without the slightest obligation. Just write us.

Circle 451 on Page 19

How many times can this nut be re-used?



ON ANY BOLT OF STANDARD QUALITY, THE NYLON INSERT ELASTIC STOP® NUT PROVIDES DEPENDABLE LOCKING TORQUE

for over 50 on-off cycles

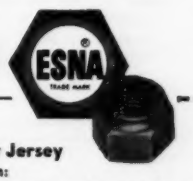
The remarkable wear resistance of the tough nylon collar plus its elastic recovery characteristic make it possible to remove and re-use the standard Elastic Stop nut at least fifty times. This familiar red collar—an integral part of an Elastic Stop nut—grips the entering bolt threads with a perfect fit which dampens impact loads and resists turning under the most severe conditions of vibration and shock. When the nut must be removed for routine maintenance, the nylon collar tends to resume its original shape and, on re-installation, grips the bolt threads as effectively as on the original installation.

Prove it to yourself! Check the coupon for a copy of Recommended Test Procedure for Determining Re-usability.

Re-usability is just one of the advantages of the nylon insert Elastic Stop nut. The constant torque that locks the nut at any position on the bolt: the inertness to gasolines, oils, salt atmospheres, cleaning compounds and common acids: the easy identification on the assembly line or in the field: the one piece construction that simplifies installation and reduces cost—these special features have made the Elastic Stop nut the standard of industry for tough applications.

Elastic Stop nuts are available in thin and regular height hex types in sizes ranging from a watchmaker's 0-80 through 3 inches, also many special shapes to meet your unusual design problems. In standard finishes and materials including carbon and stainless steels, brass, duronze and aluminum.

ELASTIC STOP NUT CORPORATION OF AMERICA



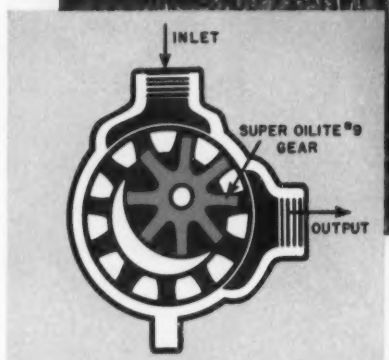
See the
NEW VARIGRIP
quick release fastener

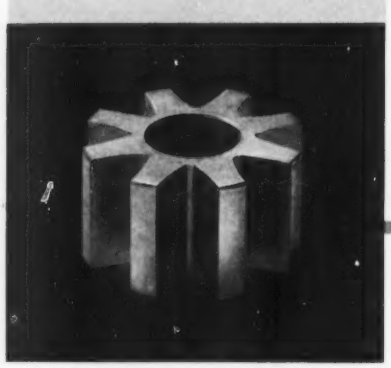
Elastic Stop Nut Corporation of America
Dept. S31-124, 2330 Vauxhall Road, Union, New Jersey
Please send me the following free fastening information:

- ☐ Recommended Re-usability Test Procedure
- ☐ Bulletin No. 5901 showing stop nut design applications on heavy-duty equipment.
- ☐ ESNA condensed hex nut catalog No. 706.

Name_____
Title_____
Firm_____
Street_____
City_____ Zone____ State_____

Circle 452 on Page 19





Double Sprayer Output, Cut Costs 75% with Oilite Precision Gear

The search for a more durable star gear at less cost led Hahn, Inc., Evansville, Indiana to investigate Amplex powder metallurgy. Amplex engineers came up with an answer that far exceeded Hahn's expectations.

Formerly machined from cast bronze, the gear is now produced in a single press operation of hardened Super Oilite No. 9†. By eliminating scrap and machining operations like turning, boring, cut-off and hobbing, Amplex reduced the cost of the gear approximately 75%. But that's not all . . .

Despite exposure to acid-forming, gritty fertilizers and pesticides, the oxide-coated Oilite gear proved 5 times more durable than its predecessor! Tough Super Oilite No. 9 proved so remarkably wear-resistant, Hahn was able to double the pump's gpm output.

What do *you* look for in components—lightweight, close tolerances, corrosion resistance, wear resistance or superior surface finish? Amplex can supply quality-controlled parts in volume that meet *all* of these requirements.

To put superior performance at less cost into your products, contact the nearest Oilite Engineer. Look for him in the Yellow Pages under "Bearings" or write Department S-12.

† Only Chrysler makes Oilite

QDP or PDQ?*

Why risk excessive production and warranty costs? You can depend on Amplex for top *quality* components, prompt *delivery* and a reasonable *price* . . . QDP! The result is parts that reduce your manufacturing and selling costs.

* Quality-Delivery-Price vs. Price-Delivery-Quality

SINCE 1929 — A CHRYSLER OILITE PRODUCT

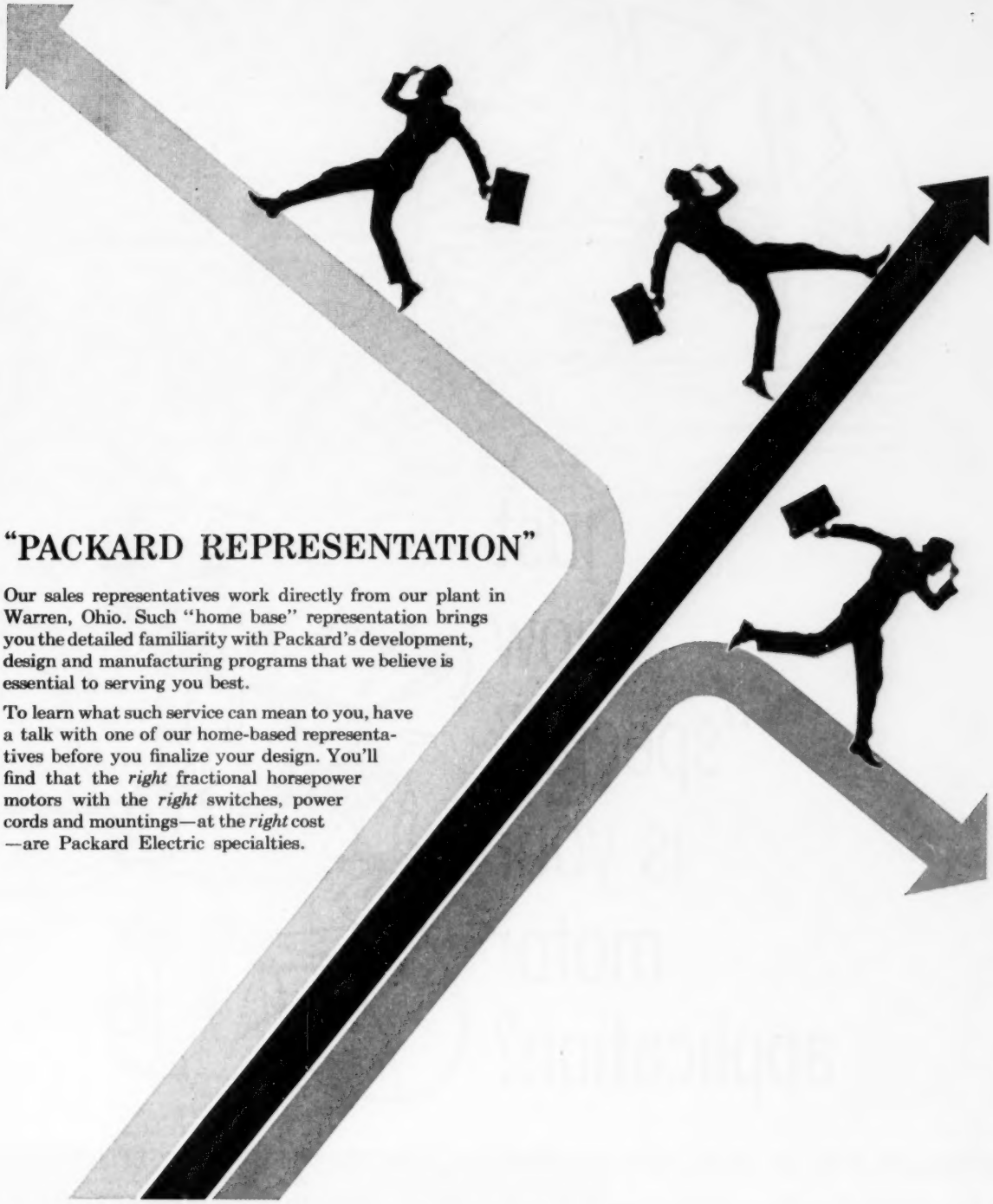
the most trusted name in powder metallurgy!

AMPLEX DIVISION

CHRYSLER CORPORATION, DETROIT 31, MICHIGAN

PRECISION PARTS • SELF-LUBRICATING BEARINGS • METAL FILTERS • FRICTION UNITS

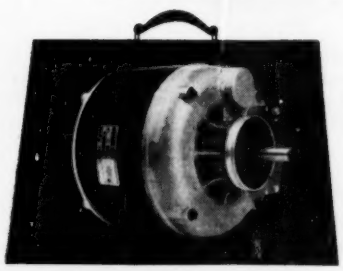
Circle 453 on Page 19



"PACKARD REPRESENTATION"

Our sales representatives work directly from our plant in Warren, Ohio. Such "home base" representation brings you the detailed familiarity with Packard's development, design and manufacturing programs that we believe is essential to serving you best.

To learn what such service can mean to you, have a talk with one of our home-based representatives before you finalize your design. You'll find that the *right* fractional horsepower motors with the *right* switches, power cords and mountings—at the *right* cost —are Packard Electric specialties.



fractional horsepower motors by

Packard Electric

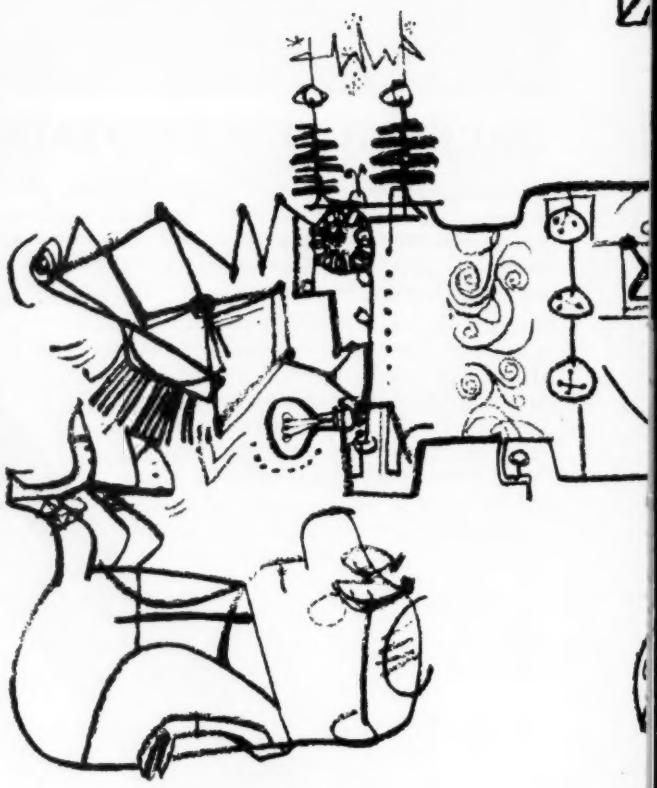
Warren, Ohio

GM GENERAL MOTORS

Appliance Motor Specialists

Circle 454 on Page 19

just how "special" is your motor application?



chances are an inexpensive Westinghouse standard fractional hp motor can do your "special" job

Your application could be a "special" one . . . special in performance demands—or even from the appearance standpoint. But does it really require a high-priced special motor? It's a good bet that a *Westinghouse standard* fhp motor will more than meet every requirement—*and do it at a big savings!* Inexpensive Westinghouse standard motors have been doing "special" jobs for years.

Call in your local Westinghouse sales engineer and have him check the job you have on the board right now. Perhaps all you're getting with a "special" motor is a "special" (higher) price.

Westinghouse offers a full line of completely standard 48- and 56-frame motors—"specially" designed to the very top of NEMA specifications to give super-standard performance. For the full story write: Westinghouse Electric Corporation, Mr. C. B. Jakes, Industrial Motor Department, Lima, Ohio.

Lower Price! . . . much lower.
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Sure Deliveries! . . . right from the shelf.

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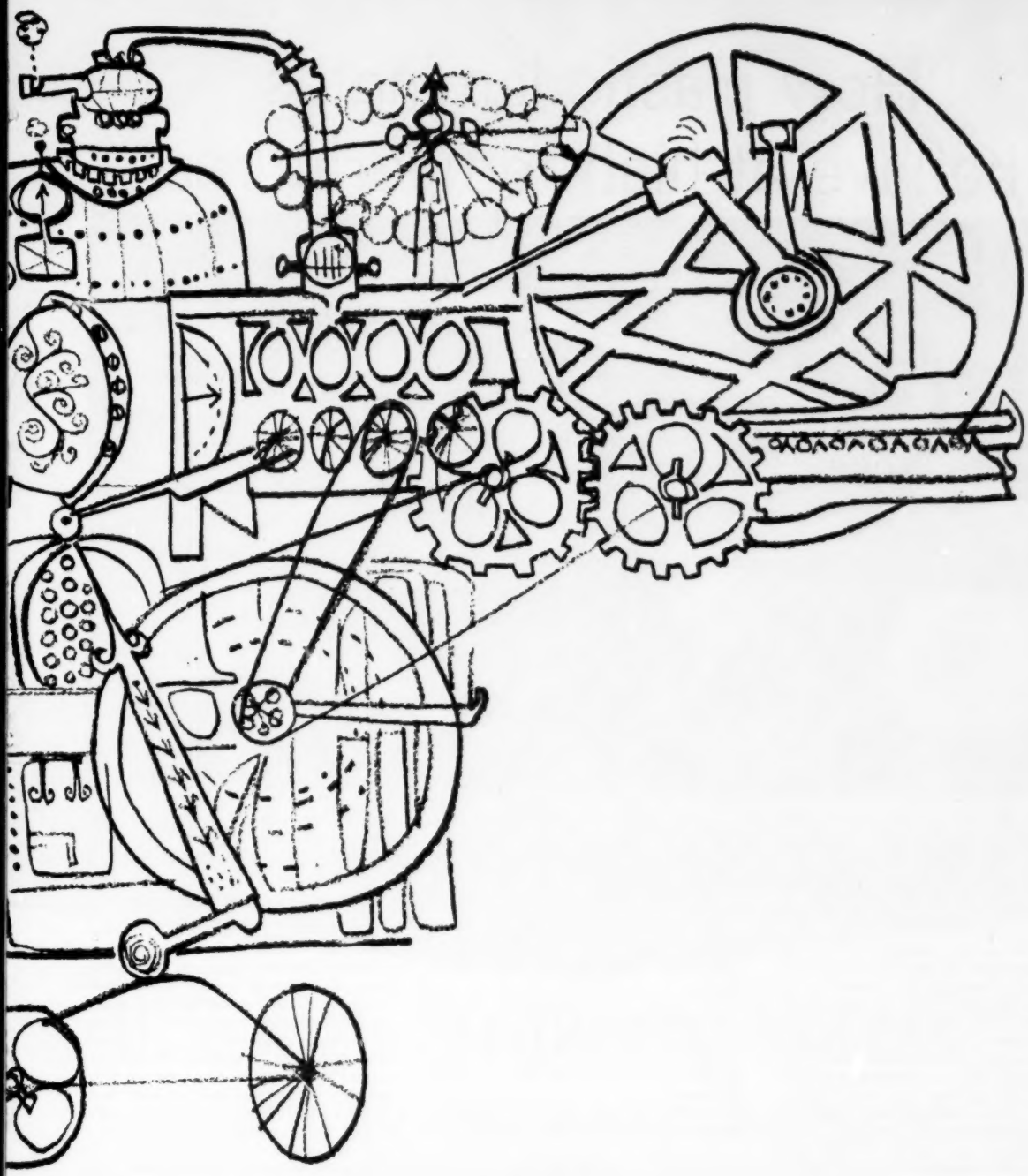

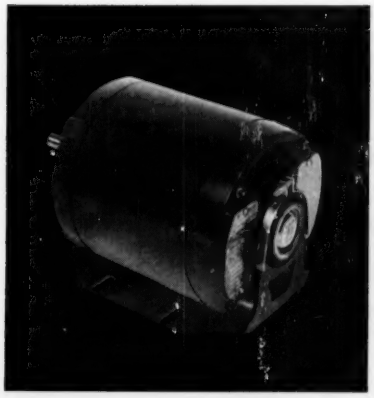

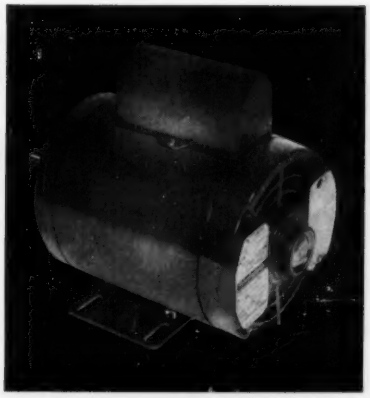

YOU CAN BE **SURE**... IF IT'S

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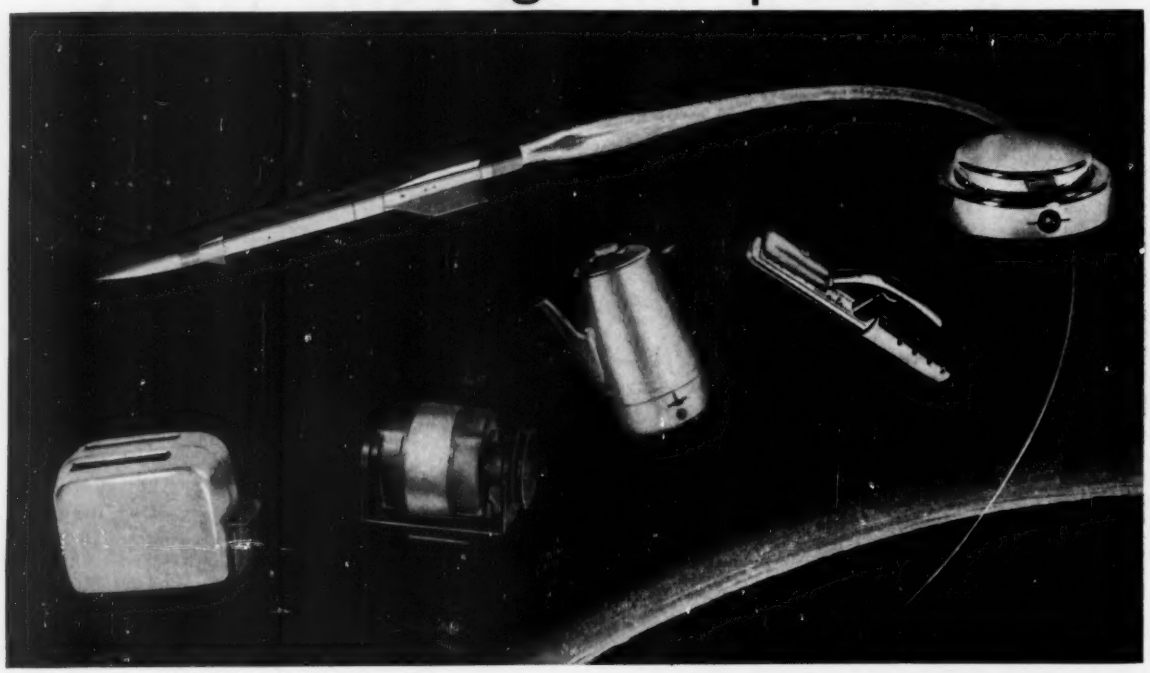
Circle 455 on Page 19

How plastic laminates behave at high temperatures



"How high is up?" to quote an old riddle, just about describes the high temperature possibilities of plastic laminates.

To a missile expert a high temperature might be in excess of 5000°F or of 20,000°F. To many of us high could mean 180°C, or over 250°C.

The key to the situation is Temperature Endurance. Where high temperature resistance is required, as in missile applications, the useful life of the part may be a matter of seconds. Under these conditions recent experiments show that reinforced organic plastics can compete with refractory metals and ceramics. And there are indications that the "old reliable" phenolic resin laminates might outshine the newer resins in this respect.

All of this is exciting yet the larger need is for plastic laminates which will endure moderately elevated temperatures for a long time. The A.I.E.E. defines Class H and Class C materials as those which "by experience or accepted tests" can be shown to be capable of operation at temperatures of 180°C or 220°C respectively.

Tests of 7 standard grades of plastic laminates were made by members of the Laminated Products Section of N.E.M.A. (Table 1).

Obviously, Grades XX and LE are not 180°C material. Grade XXXP has excellent electrical properties after exposure. Grades G-5 and G-7 have excellent mechanical properties and good electrical properties.

Similar tests were made on 4 standard grades at 250°C with these results:

Table 1
Properties at 180°C after 1000 hours exposure to 180°C

Grade	Flexural Strength	Dielectric Strength	
		Perpendicular	Parallel
	psi	V.P.M.	V.P.M.
XX	5600	*	170
XXXP	4100	530	250
LE	400	*	*
AA	5400	55	76
G-5	17500	112	143
G-7	18700	290	200
G-10	5200	160	178

*Specimens blistered

Table 2
Properties at 250°C after 1000 hours exposure to 250°C

Grade	Flexural Strength	Dielectric Strength	
		Perpendicular	Parallel
	psi	V.P.M.	V.P.M.
AA	800	50	54
G-5	1900	108	77
G-7	11800	211	250
G-10	not tested	112	100

These same materials often are satisfactory at temperatures in excess of 5000°F for a number of seconds required in these types of applications.

Just as the tests hold great promise for the future of laminated plastics in the very high temperature field, so do the tests in the moderately elevated temperature applications demonstrate the remarkable endurance of plastic laminates.

Consider Other Properties

The thermal resistance and thermal endurance of laminates such as Synthane must be viewed in relation to other properties. Commercial applications include toasters, ironers, space heaters, water heaters, welding equipment, motors, generators, circuit breakers, electric furnaces and ovens, jet engines. These applications may require also resistance to moisture, chemicals, wear, ageing; ease of fabrication, mechanical strength, light weight. Since the life of a laminate in a heat environment may be affected by conditions not present during actual tests, special test procedures may have to be established. Synthane Corporation will be very happy to help you find a laminate suitable for your temperature-life problem. Write Synthane Corporation, 5 River Road, Oaks, Pa.

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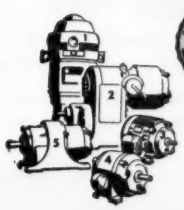

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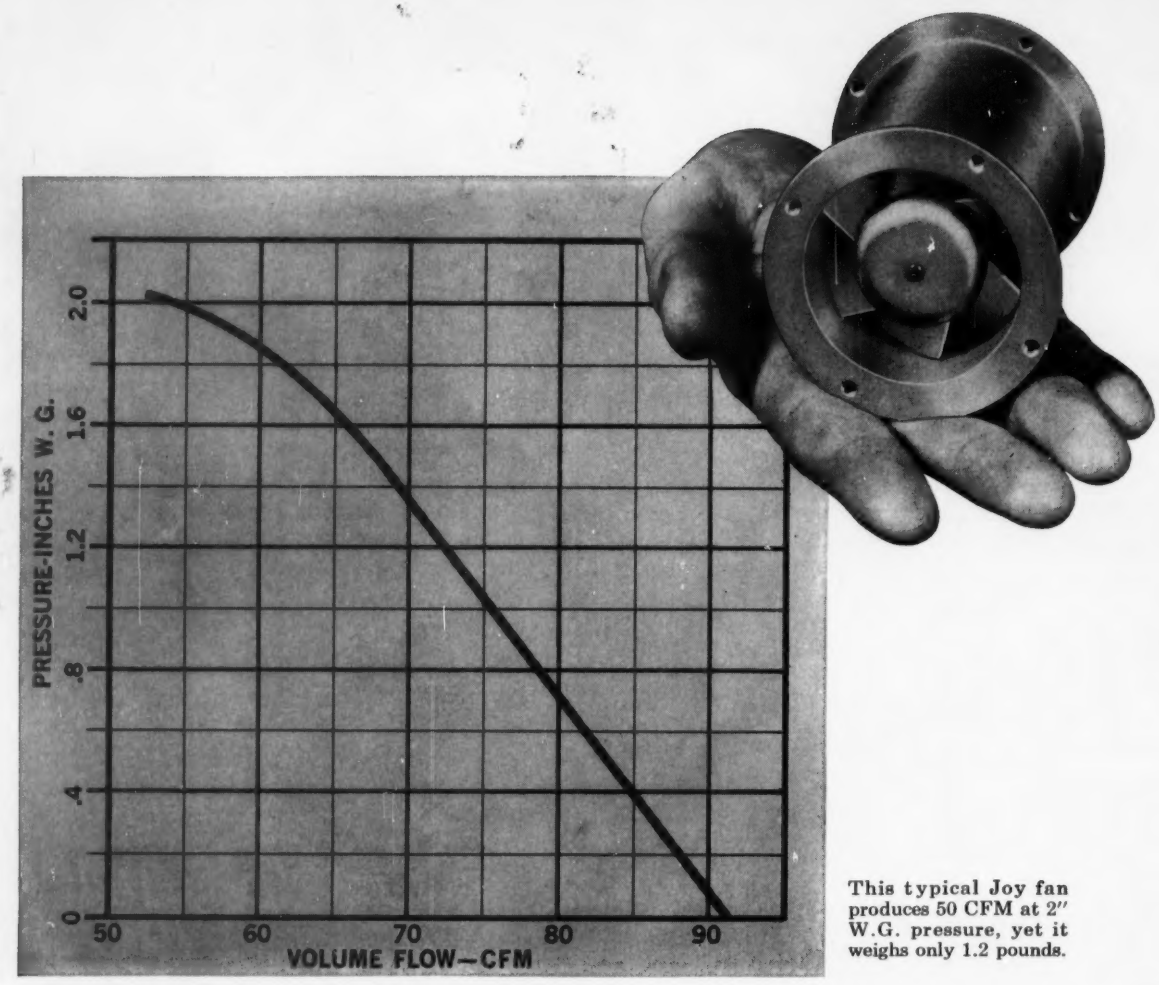

This typical Joy fan produces 50 CFM at 2" W.G. pressure, yet it weighs only 1.2 pounds.

➡ *Joy Design Means:*

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Joy aircraft and electric fans are designed to provide maximum CFM per pound of fan. The inherent high efficiency of the basic vaneaxial design, with the motor mounted inside the fan, has made Joy fans standard wherever weight or size is a critical consideration.

Joy fans meet Mil Specs, and have been accepted for both airborne and ground installations. RCA, Boeing, Douglas, Goodyear, Motorola, Lockheed, and Raytheon are just a few of the firms incorporating Joy fans in their products.

Over 340 standard models are available, and custom design can be supplied to meet your special requirements. For complete information on how compact, efficient Joy fans can solve your design problems, write for Bulletin 927-64B.

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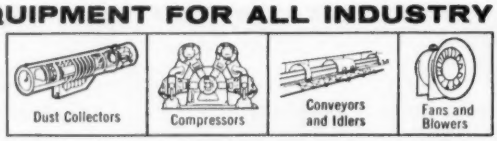

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Circle 458 on Page 19

INNERCORES! Pick your metal: brass, 356 alloy bronze, 48% nickel alloy steel, monel, stainless steel; other alloys. Seamed or seamless, name the properties you need and ask TITEFLEX. **Remember, we manufacture it.**

freedom of design with titeflex flexible metal hose

BRAIDING! Round wire for maximum flexibility, flat ribbon for high pressures and maximum abrasion resistance. **Metals:** silicon-bronze, nickel, AISI-321 stainless, copper clad steel. **Remember, we manufacture it.**

FITTINGS! Guaranteed against blow-off at specified range of temperatures and pressures. TITEFLEX engineering makes the fitting virtually part of the hose. Assemblies of any length. **Remember, we manufacture it.**

It's lighter!
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It has a smaller bending radius than most competitive hose. Yet TITEFLEX quality is so perfectly controlled that its features meet or surpass the really tough specifications. And TITEFLEX flexible metal hose is available with innercores and braid of many superior metals and alloys to match your needs.

Get more freedom in your designs . . . where fluids are carried between connecting parts of equipment or machinery . . . between misaligned parts . . . where you wish to absorb vibration . . . or to simplify multiple bend situations.

TITEFLEX engineers can help you no matter what you demand in flexibility, operating temperatures, fluid media, or pressure ratings. Ask your TITEFLEX distributor in the Yellow Pages, or write direct.

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from end to end, inside and out, made right in our own plant

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Circle 459 on Page 19

AE

TO THE ENGINEER

looking for an airtight case

Need relays or stepping switches that will stay fresh as daisies—even in environments of high humidity, gritty dust, or extremes of temperature or pressure? *You can get them,* securely housed in ideal atmospheres of their own.

AE makes an airtight case out of every job by completely evacuating the prewired assembly, replacing the air with a dry, inert gas to a pressure of at least one atmosphere, and tightly sealing the housing. Then we test it, and if there's a single, tiny leak—enough to pass 1 cc of air in 30 years—we reject the assembly! Here's real protection from adverse environmental conditions (from tampering, too).

Ask for AE's Catalog 4083 on Hermetically Sealed Enclosures. It shows the wide variety of housing sizes and shapes available—with hook terminals, socket or cable plug-ins, or special printed-circuit connectors. Into these housings AE will put relays and switches assembled and wired to your specifications—or we will design and deliver complete control packages or systems. Chances are we can do the job at less cost, too.

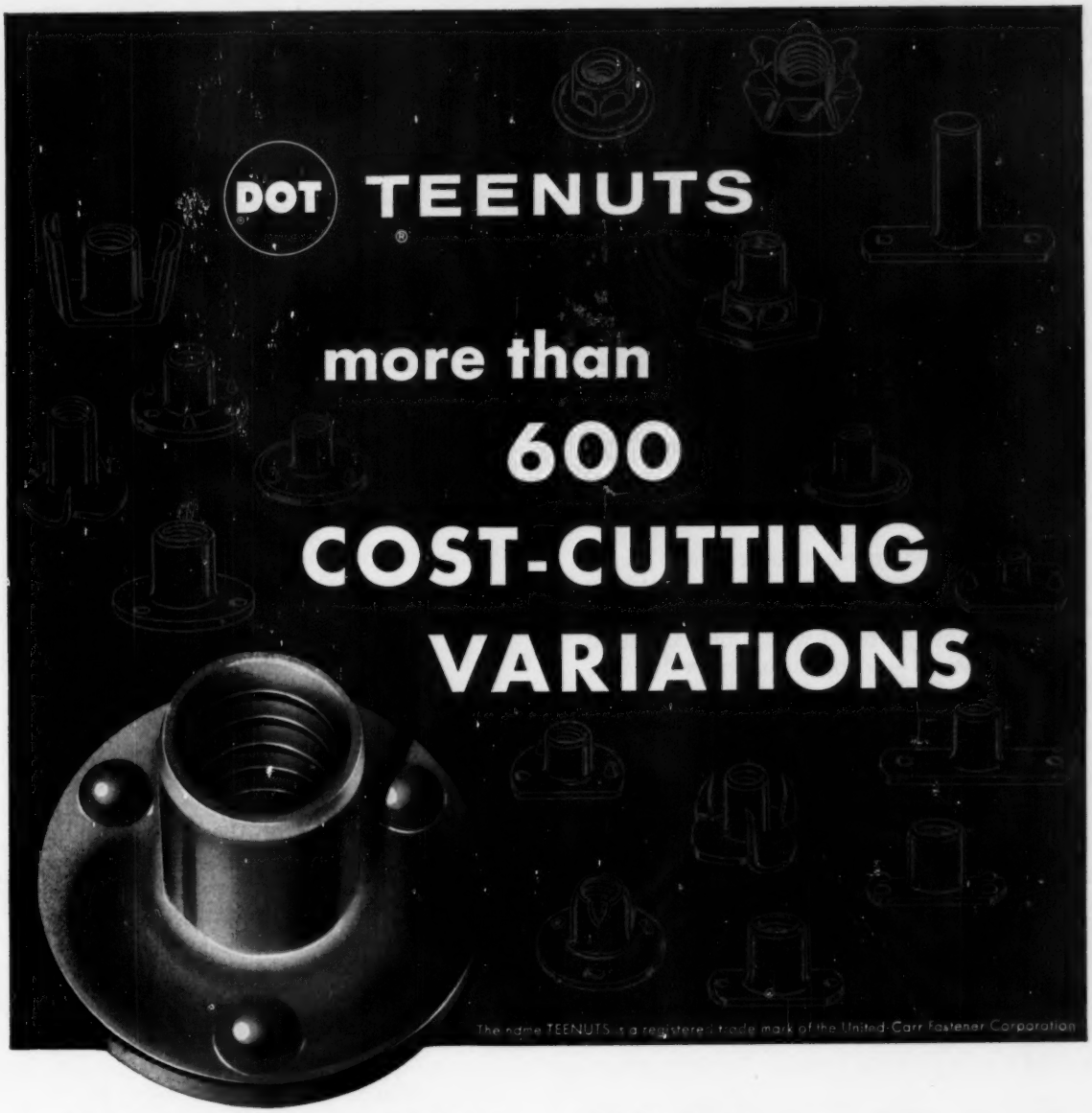
If you have a sticky control problem, just write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois. *In Canada:* Automatic Electric Sales (Canada) Ltd., 185 Bartley Drive, Toronto 16, Ontario.

AE CAN DO

AUTOMATIC ELECTRIC GENERAL SYSTEM

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS



Since the first TEENUT was developed by Carr Fastener in 1927, more than 600 different modifications of this extremely versatile device have been designed and manufactured in true, mass-production quantities.

By combining nut and washer in one solid unit, the DOT TEENUT offers exceptional strength and security and eliminates the need for tapping. Its flanged base can be formed with welding bosses for attachment to sheet or solid metal structures . . . with prongs for wood . . . or with any number of different special bases for particular applications. DOT TEENUTS can be made in heat and corrosion-resistant materials and they can be provided with moisture-seals and vibration-proof, self-locking barrels.

Once mounted, the DOT TEENUT stays put and can't be lost or mislaid . . . an advantage at any time and a necessity where blind fastening is required.

Wide experience in the proper application of DOT TEENUTS and a multitude of other special-purpose fasteners enables your DOT field representative to provide prompt and effective solutions to a tremendous variety of fastening problems. Where special design work is needed, he can bring you the services of a design-engineering group unequalled in its field.

The DOT TEENUT catalog is an invaluable reference . . . yours on request.

MAKERS OF DOT FASTENERS

CARR FASTENER COMPANY
Division of UNITED-CARR Fastener Corp., Cambridge 42, Mass.

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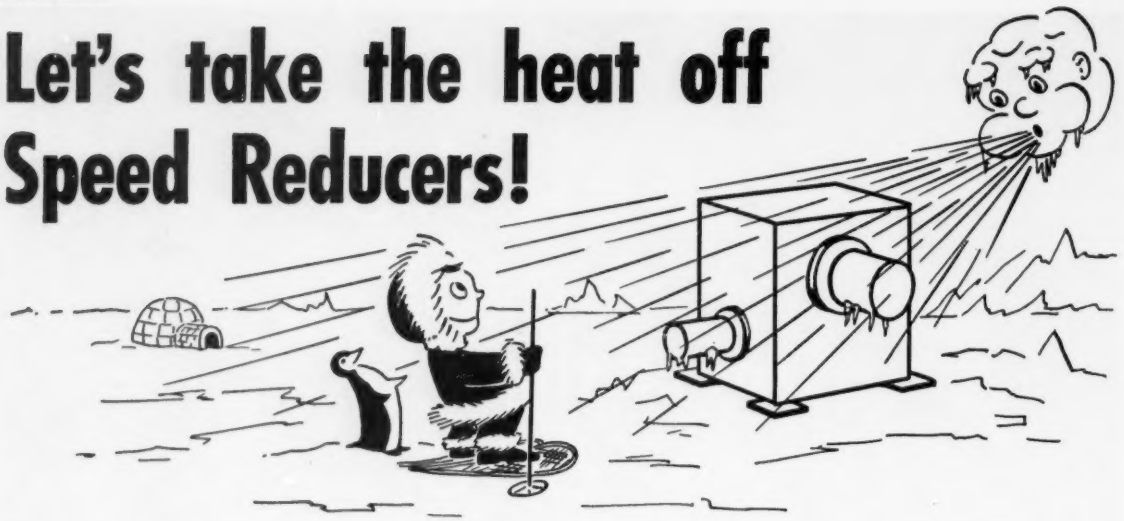
Let's take the heat off Speed Reducers!



A worm gear speed reducer is one of the toughest little customers in captivity. It reduces speeds day-in, day-out, with little complaint. While it works long and hard, it has limitations—set by ratio, center distance, RPM, mechanical and thermal HP ratings, etc. And, depending upon how precisely it was selected and fitted to the job requirements, it will do what it has to do.

But sometimes it's forced to play outside of its league. It must cope with job requirements that vary from here to there—normal 8 to 10 hour service without recurrent shock, the same length of service where there is some shock loading, continuous low-speed service and almost countless others. But the thing that really puts the pressure on reducers, the thing that's lurking in *every* set of job requirements—is h-e-a-t.

When you exceed the thermal capacity of a reducer for more than an hour or so, excessive temperature thins the lubricant resulting in wear; material, bearing and oil seal failures; etc. Of course, the proper lubricant will help but it can't cure the continuing problem of excessive heat.

So how can we lick this toughy? One way is to build the reducer housing oversize, big enough to radiate the heat away and keep temperatures down. But this type sticks out in aisles, louses up compact designs and barks shins. Then, we might try a smaller housing complete with fins on it to dissipate the heat. If this still doesn't work, another trick is to use a reducer with capacities and ratings a step above the ones we need. This is sending a man to do a boy's job. It's impractical, inefficient and costly. There *has* to be an easier, better, saner and cheaper way to do it. And there is!

In certain cases, where the size and type of reducer permits and where we can gain enough in thermal HP rating to keep heat generation in bounds, Cone-Drive Gears does it with fan-cooling.

What's that? Simple. Just add a fan to the worm shaft plus the necessary air shields, fan cover, etc., and presto!—heat is no longer a problem. The air shields direct the fan-pushed air over the fins on the lower portion of the reducer. The fins are shaped and spotted to guide the air stream where it is needed. Thermal HP ratings are boosted tremendously, as high as 147% above those of standard reducers in some cases! Those over-worked, over-heated reducers will now do the job you bought them to do.

Other advantages? They're here in abundance. The size of the reducer stays the same. All parts on a Cone-Drive fan-cooled reducer are 100% interchangeable with parts for standard reducers. Oil capacity is identical. Shields are quickly removed without disconnecting the reducer. (This is important where severe operating conditions make periodic cleaning necessary). The reducer can also be operated *without* fan-cooling just by taking off the fan and shields.

This simple addition to standard Cone-Drive HU speed reducers might be just your answer—might save you some money. Write for Cone-Drive's Bulletin CD-218. It will tell you all about the full line of Cone-Drive double-enveloping worm gear reducers as well as the fan-cooled kind. Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

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Circle 462 on Page 19→

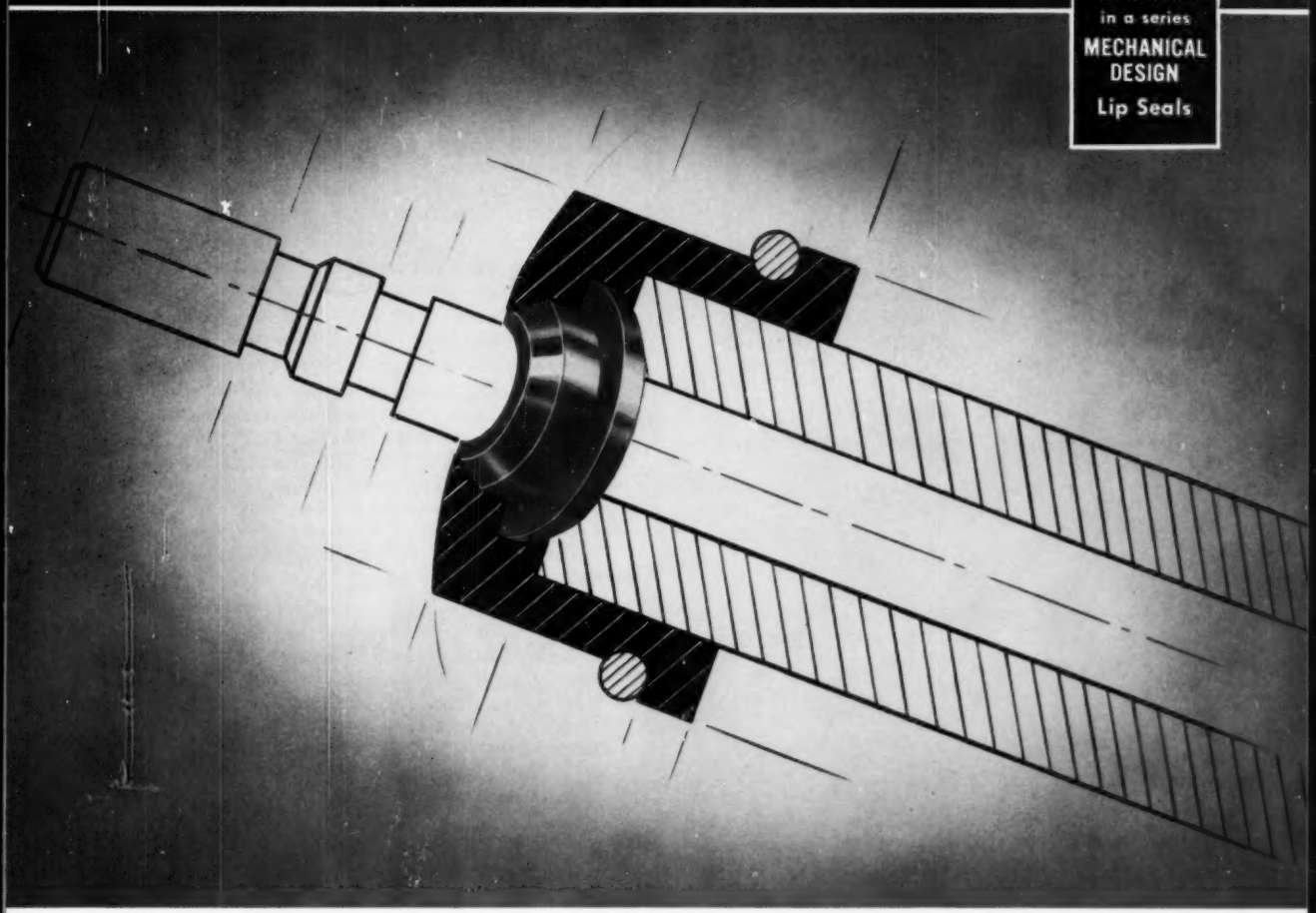
DU PONT

ENGINEERING FACTS ABOUT

TEFLON®

FLUOROCARBON RESINS

Number M-4
in a series
MECHANICAL
DESIGN
Lip Seals



Lip seal of a TFE resin provides oil seal with low friction . . . low wear . . . longer life

The valve guide seal, shown enlarged above, is used as an oil-control ring in automotive engines. Made of a TEFLON TFE fluorocarbon resin, the seal stops the passage of liquid oil, but, by acting as a lubricant itself, assures low wear of rubbing surfaces, has a long effective life, and stops burn-up of oil.

In all types of lip seals, the exceptionally low static coefficient of friction of TFE resins—less than 0.04—is a significant design advantage. It often makes possible the use of non-lubricated seals, with resultant savings in time, maintenance and the elimination of contamination problems. In addition, TFE resins offer exceptional resistance to corrosion and maintain their unique properties over a wide temperature range. But even when adverse conditions are not present, lip seals made with TFE resins offer the designer increased performance reliability, freedom from costly maintenance problems, longer effective seal life and, frequently, opportunities for simplified design.

On the next page you will find additional information on the properties of TFE resins that make their use in lip seals advantageous, and notes on the use of these resins in the various types of lip seals.

OVER

TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.

Lip seals of TFE resins: DESIGN CONSIDERATIONS

TEFLON TFE resins are being employed in all types of "automatic" seals, including cup seals, rod seals, "U's", "V's" and squeeze-type seals such as "O"-rings. There are many modifications by various processors of TFE resins in making these types of seals, and where specific problems occur, these suppliers stand ready with their products and experience to solve the problem. Considered below are the basic characteristics of TFE resins that have enabled designers to lengthen the life, broaden the use and improve the design of all types of automatic seals.

Relevant properties

1. Low coefficient of friction. TFE resins are unique in having a static coefficient of friction even lower than the dynamic value of 0.04, thus eliminating problems of stick-slip. At high loads and low velocities TFE resins have a lower friction than any other solid material, including graphite and molysulfide. They have a significantly lower static friction (as low as 0.016) than the best lubricated metal rings.

2. Temperature resistance. The exceptional thermal stability of TFE resins makes them suitable for continuous service at 500°F. At this temperature, and also at very low temperatures, they exhibit the same low frictional properties as at room temperatures.

3. Chemical inertness. TFE resins are completely inert to virtually all chemicals and solvents, such as strong caustics, sulfuric and hydrofluoric acids, aqua regia, aliphatic and aromatic gasolines, alcohols, esters, ketones and ethers up to their boiling points.

4. Other properties. TFE resins in seals are tough, abrasion-resistant, and have the ability to imbed hard foreign particles without apparent effect on the cylinder or on themselves.

The use of TFE resins for various types of lip seals

The unique combination of properties offered by TFE resins makes it possible for the designer to realize fully the advantages inherent in each of the basic types of lip seals:

Cup Seals: When reciprocating plungers and pistons weave through small misalignment, cup seals of TFE resins are used to solve the problem. They are also used for service with liquids and gases where large clearances, less machining time and simplicity of design are desirable. The exceptional frictional properties and self-lubricating properties of TEFLON make operation without lubrication possible. Cup seals made of TFE resins are available in a complete size range, and are made by machining, molding or postforming. Postformed seals have built-in stresses that make up for problems caused by thermal cycling which may arise when operating temperatures vary by more than 130°F.

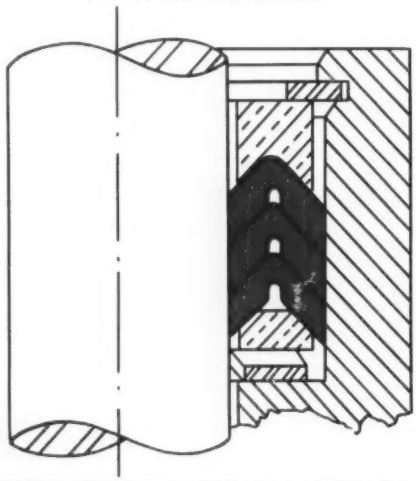
Rod Seals: In general, the same design considerations apply to rod seals, or flange packings, as for cup seals. They are also used for either reciprocating or rotary motion. Rod seals made of TEFLON resins are particularly useful when small space is required.

"U" Seals: A combination of the cup and rod seal designs, "U" seals made with TEFLON have been used successfully in applications where it is desirable to eliminate excessive packing friction at low operating pressures without narrowing tolerances. They may be applied to piston rods to prevent the entrance of air into the cylinder. They may also be used as wiper rings to remove dirt and dust from rods. Here the ability of TFE resins to imbed particles further reduces wear and assures longer life.

"V" Seals: Another common type of automatic sealing device embodying TEFLON is the spring-actuated "V" ring set shown in Figure 2. These rings are similar to a "U" seal, but more rings are used in the housing. This design has more sealing edges which lessen the danger of shutdown because the next ring can take over when a ring fails or is damaged.

Male and female adaptors are available to place at the ends of the "V" ring seals. They are used to prevent the rings from deforming under extremely high pressures in the case of the female and to insure automatic lip action and a positive seal under pressure in the case of the male adaptor.

FIG. 2. V-RING SEAL ASSEMBLY



Other design considerations

In lip-type seals of TEFLON TFE resins, it is preferable that surface speed be limited to 600 feet per minute for unlubricated rotating shafts, since heat removal is a problem. On reciprocating movement, heat dissipation permits greater surface speed. A finish of at least 16 rms is preferred on both moving and static surfaces.

FOR MORE INFORMATION...

Further details on the properties and design characteristics of TEFLON TFE fluorocarbon resins, and their application to lip seals and all types of seals, may be obtained from your local supplier. You'll find him listed under "Plastics—Du Pont" in the Yellow Pages. Supplementary engineering data on the properties of TFE resins is available on request from your supplier or from: E. I. du Pont de Nemours & Co. (Inc.), Advertising Department, Room T-2512, Nemours Bldg., Wilmington 98, Delaware.

In Canada: Du Pont of Canada Ltd., P.O. Box 660, Montreal, Quebec.

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TFE-FLUOROCARBON RESINS

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

. . . FAST, UNIFORM PROCESSING — 1960 . . .

CAMBRIDGE METAL-MESH BELTS are the answer to the big problems you'll face in the competitive 60's—tighter operating costs, higher production and consistent quality.

Continuous movement of foods, metal parts, ceramics or chemicals on Cambridge Belts through processing operations speeds production and eliminates costly manual handling. Open mesh construction allows heat, cold or liquids to flow through the belt and around the product for thorough, uniform treatment. Superior belt design and manufacturing techniques mean longer life, fewer repairs, lower operating costs.

Belts can be made heatproof, coldproof or acidproof — in any mesh, weave, metal or alloy — with any side or surface attachments.

Whether you're designing machinery for your own use, or for resale, the Cambridge Field Engineer in your area will be glad to discuss the many advantages of Cambridge Belts — from manufacturing to installation and service. Call him today. He's listed in the yellow pages under "Belting, Mechanical". Or, write for FREE 130-PAGE REFERENCE MANUAL.

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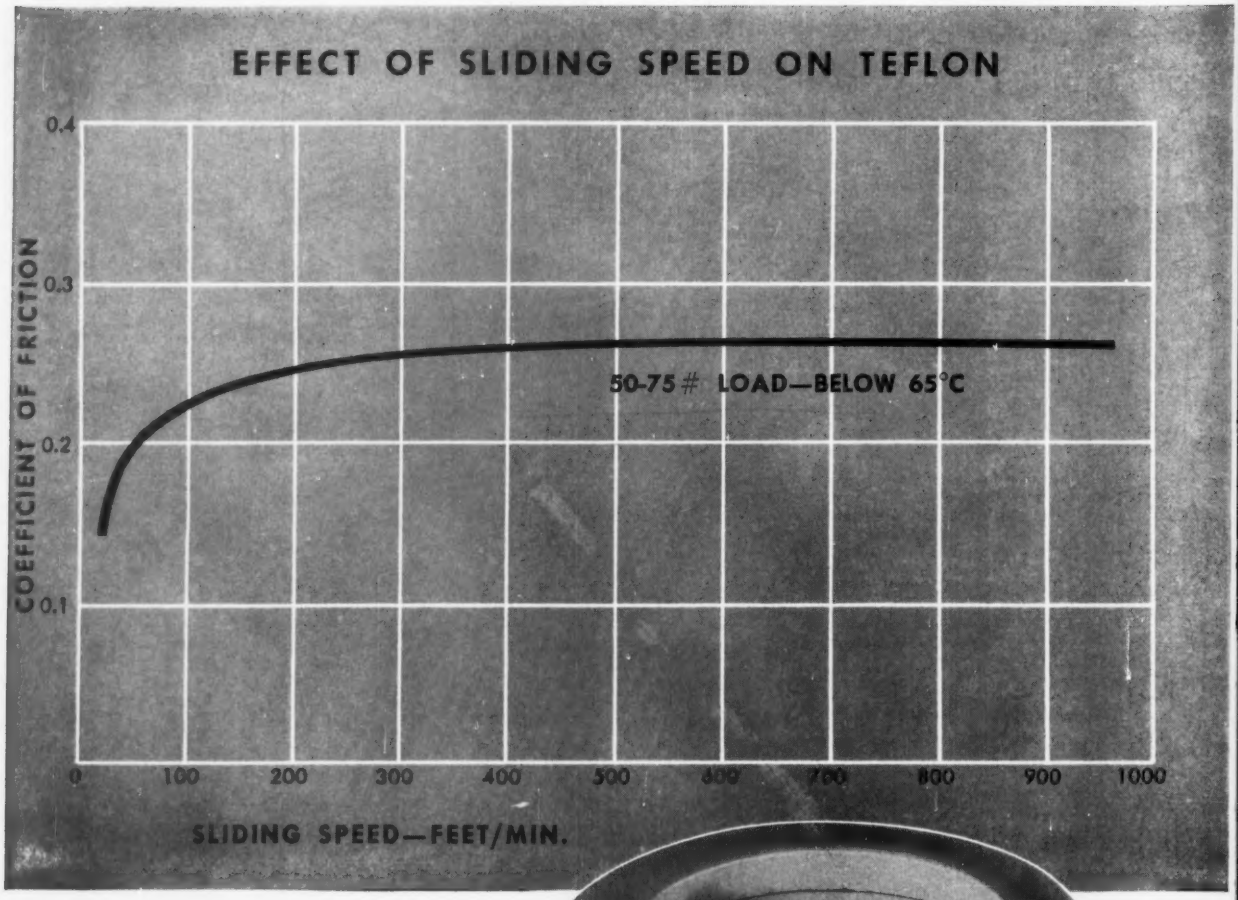
Circle 463 on Page 19

Wherever fluid power is used—

GARLOCK PACKINGS OF TEFLON* MAKE



CHEVRON Packing made of Teflon

*DuPont Trademark for TFE fluorocarbon resins
‡Registered Trademark

A BIG DIFFERENCE IN EFFICIENCY

FRICTION AND WEAR—enemies of top performance anywhere—can be held to the absolute minimum on all hydraulic and pneumatic applications if you specify Garlock CHEVRON‡ Packings, "V" Rings, "O" Rings, or Molded Cups made with Teflon.

CHEVRON PACKINGS of solid Teflon—or coated with Teflon—are as close to "frictionless" as you'll find. First of all, Teflon has the lowest coefficient of friction of any solid material in use today. Moreover, the CHEVRON itself is designed to permit free operation with minimum friction at all pressures. Here's how: with increasing pressures, CHEVRON packing rings tighten to prevent leakage. As pressures decline, the rings instantly ease off, permitting free operation of the rod, ram, or piston without leakage. This exclusive hinge-like construction (see illustration) lengthens packing life and, with proper initial adjustment of the gland, eliminates all further adjustments necessary to compensate for pressure variations.

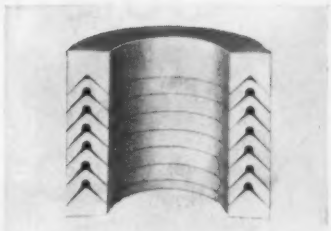
TEFLON "V" RINGS for higher pressures. Flexible enough to respond quickly to low gland and fluid pressures due to tapered "V" design.

"O" RING PACKINGS made completely of, or coated with, Teflon provide exceptional anti-friction qualities on equipment where a round-bodied seal is required. And, to overcome the characteristic stiffness of solid Teflon rings, a new slotted Teflon ring is available to simplify installation in standard AN grooves.

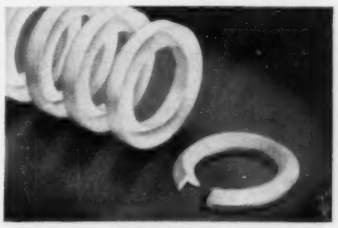
TEFLON-COATED CUPS—the first advance in cup design in thirty years. Garlock has perfected a technique whereby cups are coated with a thin layer of Teflon which then becomes an integral part of the cup. Teflon-coated cups reduce breakaway torque, running friction, and completely eliminate "squealing."

OTHER FINE ADVANTAGES of Teflon packings: Solid-Teflon is chemically inert, tough non-flammable, resilient, long wearing. It can be applied against all hydrocarbons and new synthetic hydraulic fluids at temperatures ranging from −100° F to +500° F.

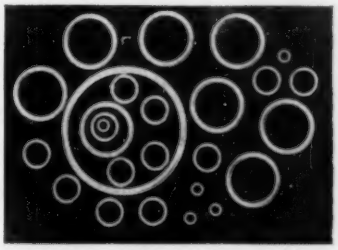
GET TOP EFFICIENCY through reduced friction and downtime. Discuss Garlock Teflon Packings with your local Garlock representative. He can recommend from the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals for every need. Call him, or write for Catalogs AD-115 (CHEVRON Packings), AD-148 ("O" Ring Packings), and AD-145 (Molded Cups).



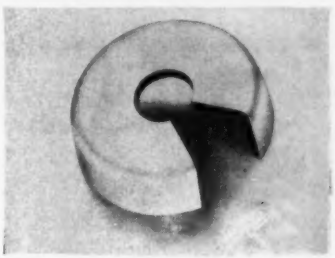
Exclusive hinge-like design adds to anti-friction feature of CHEVRON.



"V" Rings . . . flexible, low friction seal at all pressures.



"O" Rings . . less friction where round-body seals are needed.



Teflon-coated Cups, reduce breakaway torque.

THE GARLOCK PACKING COMPANY, Palmyra, N.Y.

For Prompt Service, contact one of our 26 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

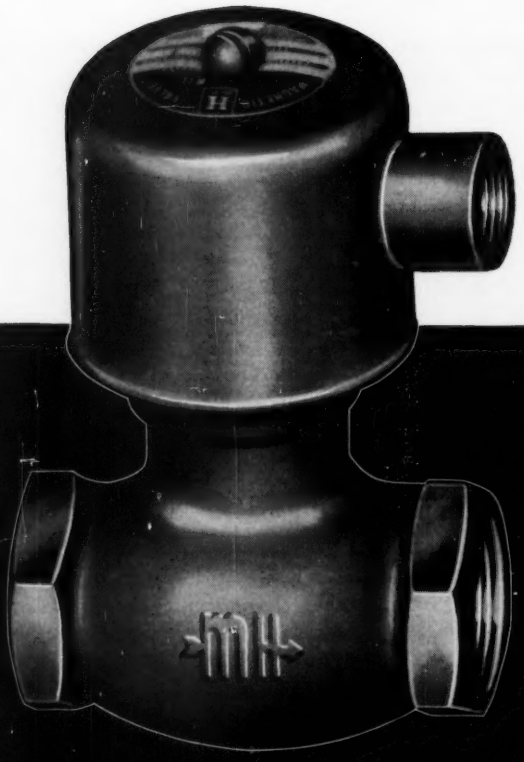
Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

Canadian Division: The Garlock Packing Co. of Canada Ltd.

Plastics Division: United States Gasket Company

Circle 464 on Page 19

NEW Solenoid Valve V-4019



for water and other light fluids

small in size, high in capacity

APPROXIMATE CAPACITY, GALLONS PER MINUTE, WATER SERVICE

Differential Pressure (psi)	1.25	3	5	10	30	40	50	100
½" Valve	5.6	8.7	11.3	15.6	27.3	31.6	35.2	50
¾" Valve	7.8	12.1	15.6	21.9	38.2	44.2	49	70

Pressure Ratings: Operating pressure—100 psi max.; 1¼ psi min. for full flow. Body rating: 150 psi, nominal body rating

Fluid Temperature Ratings: 125 F max. at 125 F ambient
175 F max. at 77 F ambient

Capacity Index (C_v): ½" size—5, ¾" size—7

Electrical Rating: 120, 208, 240 volt, 50 and 60 cycle ac

Use this pilot-operated, soft-seated solenoid valve for reliable on-off control of water or other light, non-viscous non-corrosive fluids. It's of floating-piston design for quiet operation. The power head can be rotated 360° for ease of wiring. Body material is brass. Can be used for normal and chilled water applications . . . operates from any standard SPST controller or on-off switch.

Get complete details from your nearby Honeywell field engineer. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

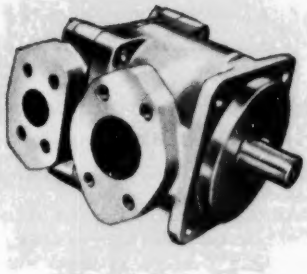
Honeywell

H HONEYWELL *First in Control*

Circle 465 on Page 19

VANE PUMP POWER for CASE®

2000 PSI...BY DENISON



2000 PSI HYDRAULIC PUMP
... is incorporated into power systems of dozens of types of earthmoving equipment by leading manufacturers. Denison 2000 psi hydraulic power gets jobs done faster with dependable trouble-free operation for toughest workloads.

DESIGNERS ENGINEERS...
Write for your copy of Bulletin P-9-3 on Denison "TID" Series Vane Pumps. Includes complete specifications and operating data.

These completely new Case tractor shovels—the W-10 and W-12 TERRALOAD'R®—deliver outstanding work capacity. They're products of the J. I. Case Co., Racine.

And ultra-efficient Denison hydraulic power is helping these high-speed Case units do excavating, loading, grading, hauling and materials-handling jobs faster ... at *lower operating cost.*

The W-10 (2 cu. yd.) and W-12 (2½ cu. yd.) TERRALOAD'R® dump-buckets get high efficiency, low-cost power from a single Denison 2000 psi vane pump.

Key advantage – high volumetric efficiency is *continuous* in Denison pumps ... no drop-off in work speed – no sluggish operation to slow up the job.

Plus these advantages –"cartridge" construction of Denison pumps means speedy in-field servicing. All-weather starting features prevents pump damage. Denison pumps guarantee less weight, less cost-per-horsepower... more payload per dollar in your earthmoving equipment.

Your Denison Hydraulic Specialist can tell you more about significantly improving equipment performance with *hydraulic power to 5000 psi.* Call him in to discuss *making your equipment more profitable to the man who buys it!*

DENISON ENGINEERING DIVISION
American Brake Shoe Co.
1240 Dublin Road • Columbus 16, Ohio

Denison and Denison HydrOILics are registered trademarks of Denison Eng. Div., ABSCO

DENISON HydrOILics

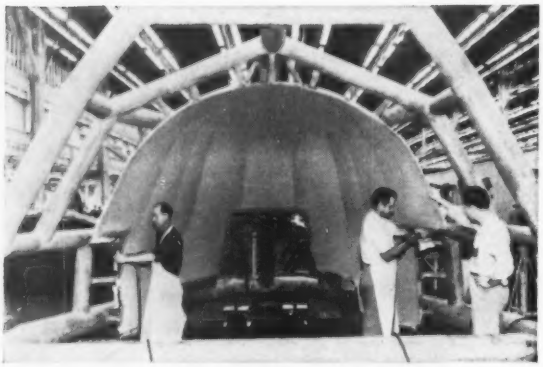
HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

1 The tube is a reinforced epoxy housing that protects:
(a) a communications antenna *(b) a radio transmitter*
(c) miniature rockets

2 Its ignition coil, completely embedded in epoxy, is safe from:
(a) moisture *(b) temperature extremes*
(c) shock

Can you pass this test on Epoxy Plastics?

(You'll discover more of their potential as design materials)



3 This airplane construction tool of epoxy-glass cloth:
(a) checks dimensions of fuselage *(b) supports the frame*
(c) is part of the mock-up

4 This tough, strong, pleasure boat hull is made from:
(a) laminated epoxy and glass fiber *(b) epoxy-coated wood*
(c) epoxy-coated metal

5 Their trip to school is safer in a bus with:
(a) epoxy-glass fiber seat frames *(b) an epoxy-sand coated floor*
(c) epoxy-embedded electrical parts

ANSWERS... *to tomorrow's needs are coming from adaptable BAKELITE epoxy plastics.*

1. Check (a). It minimizes weather and electrical interference along our defense communications lines.
2. Pick (a), (b), and (c)—and epoxy won't harm delicate windings, either.
3. (a) Checks dimensions—it's lightweight and extremely accurate.
4. (a) Epoxy-glass laminate—but epoxy coatings are great on other hulls.
5. (b) They won't slip on this floor's tough, gritty surface.

If you have questions—about designing with plastics for function, serviceability, economy and appearance—please ask us. We'll be glad to answer on the practical design and engineering uses of vinyls, epoxies, phenolics, styrenes, and polyethylenes. Just write or call any of our offices or write Dept. LW-03D, Union Carbide Plastics Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. *In Canada:* Union Carbide Canada Limited, Toronto 7.

UNION CARBIDE

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Solve Your Adjustable Speed Problems with this Combination

EATON
DYNAMATIC®
DIVISION
EATON MANUFACTURING COMPANY
KENOSHA : WISCONSIN

*AJUSTO-SPEDE®

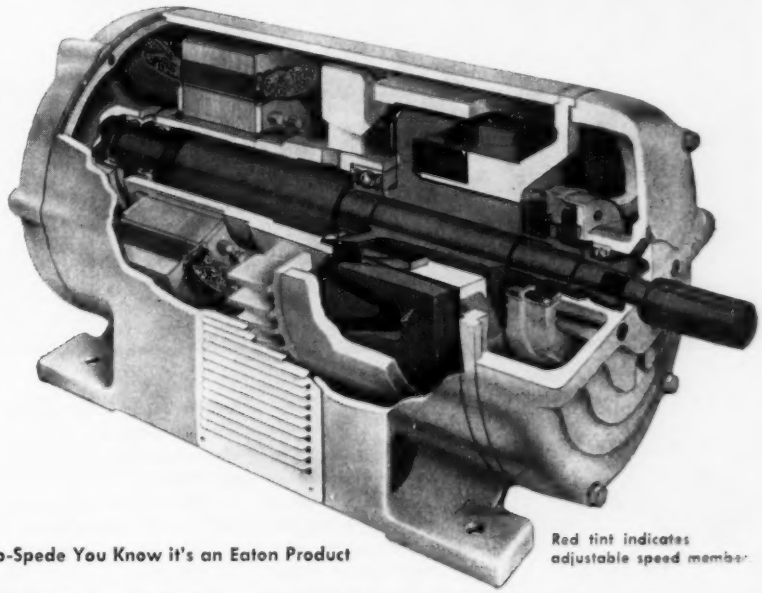
If your problem is in the field of speed control, tension control, power transmission, or testing, Dynamatic Eddy-Current Equipment is the ideal solution. Dynamatic Ajusto-Spede Drives, Couplings, Brakes, and Dynamometers are solving these problems in virtually every industry—in both plant machinery and end product applications. Dynamatic equipment can do the same for you.

Ajusto-Spede Drives and other Dynamatic units offer the important advantages of rapid response, wide speed range, quiet operation, low power loss, low maintenance costs, and stepless adjustable speeds from an AC power source.

For complete information about Dynamatic problem-solving equipment, check with your local Eaton-Dynamatic representative or distributor.

The New Quill-Type Ajusto-Spede Drive provides controlled adjustable speeds for applications from ½ HP through 7½ HP. Together with the new K-2 Electronic Control and push-button station, this new Ajusto-Spede Drive comprises a compact, low-cost, 3-unit drive package.

Send for Illustrated Descriptive Literature Covering New Models ACM-903 and 904 Ajusto-Spede Drives



Red tint indicates adjustable speed member

EATON®

*When You See the Name Ajusto-Spede You Know it's an Eaton Product

EATON DYNAMATIC DIVISION
MANUFACTURING COMPANY
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

PIONEER IN EDDY-CURRENT EQUIPMENT

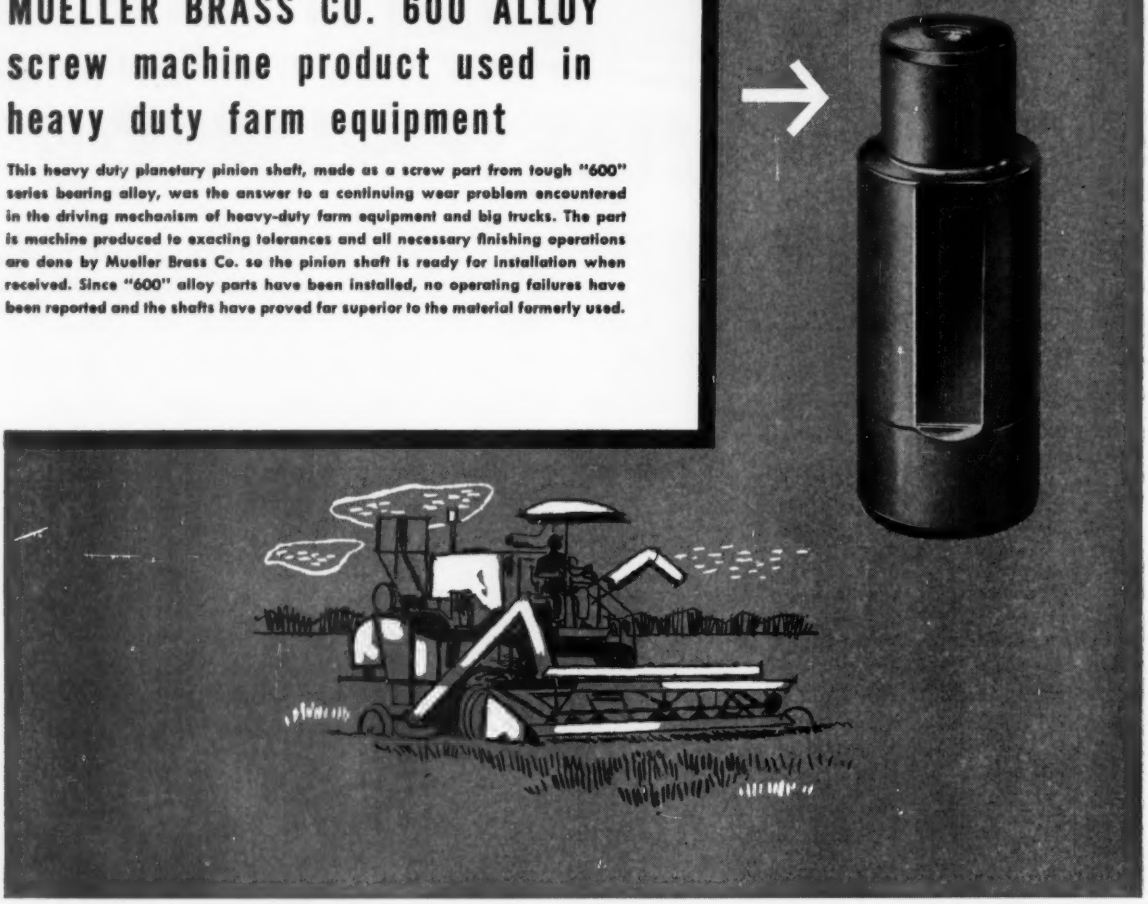
Circle 468 on Page 19

two more cases where **PARTS PRODUCED FROM provide excellent bearing properties**

CASE HISTORY

MUELLER BRASS CO. 600 ALLOY screw machine product used in heavy duty farm equipment

This heavy duty planetary pinion shaft, made as a screw part from tough "600" series bearing alloy, was the answer to a continuing wear problem encountered in the driving mechanism of heavy-duty farm equipment and big trucks. The part is machine produced to exacting tolerances and all necessary finishing operations are done by Mueller Brass Co. so the pinion shaft is ready for installation when received. Since "600" alloy parts have been installed, no operating failures have been reported and the shafts have proved far superior to the material formerly used.



MUELLER BRASS CO. ANALYSIS SERVICE

You get sound, unbiased advice on the one best method of making your parts because Mueller Brass Co. is the only fabricator in the country offering all these methods of production. An experienced Methods Analysis Department has at its command a complete knowledge of the advantages and limitations of each production process. This unique technical service is your assurance of getting the best product at the best price . . . made the one best way!

COLD-PREST IMPACT EXTRUSIONS

PLASTIC INJECTION MOLDING

MUELLER BRASS CO.

MUELLER BRASS CO. 600 ALLOY

and maximum wear resistance in tough applications

CASE HISTORY

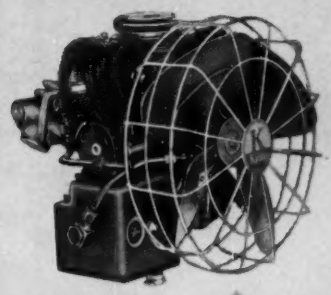
MUELLER BRASS CO. 600 ALLOY forgings used in aviation air compressors

Analyzing the job requirements of Walter Kidde & Company, Inc., for a main driving cam component to be installed in a reciprocating type of aircraft air compressor, Mueller Brass Co. Methods Analysis Engineers decided on a forging fabricated from "600" alloy as the most practical method of production. Since the cam forms the prime component of the driving mechanism, it must have good bearing wear surfaces and because the compressors are used in the aviation industry, the cams must be completely dependable. The close grained, strong forging that resists combination compressive and tensile stresses was the answer.

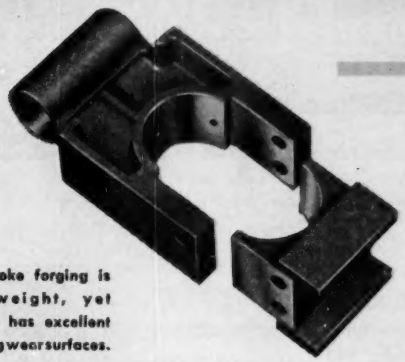
A typical compressor takes in ambient air and compresses it to 3000 psi or higher. This high pressure air is stored in metal or fiberglas containers until needed for actuation of pneumatic system components such as solenoid control valves, brake valves, manual control valves or actuators. These and other pneumatic units retract the entrance door, operate landing gear, wheel brakes, nose wheel steering systems, propeller brakes or perform other functions.

Aircraft in which Kidde compressors are installed include the Boeing 707, the Douglas DC-8, the Lockheed Electra, the Fairchild F-27 and various military aircraft.

Mueller Brass Co. produces press, hammer or cored forgings of any practical shape from a few ounces to 150 lbs. in brass, bronze, aluminum and magnesium in 27 standard, as well as special, alloys.



Aircraft air compressor equipped with hydraulic drive delivers air compressed to 3000 psi at the rate of 6 cfm.

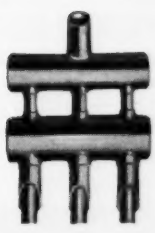


This yoke forging is lightweight, yet strong; has excellent bearing wear surfaces.

Forging is part of the main cam, the prime component of a modified Scotch-type yoke, which is the piston driving mechanism in the air compressor.

POWDERED METAL PARTS

SAND CASTINGS



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Write today for free technical literature on any one or all of the seven fabricating methods.

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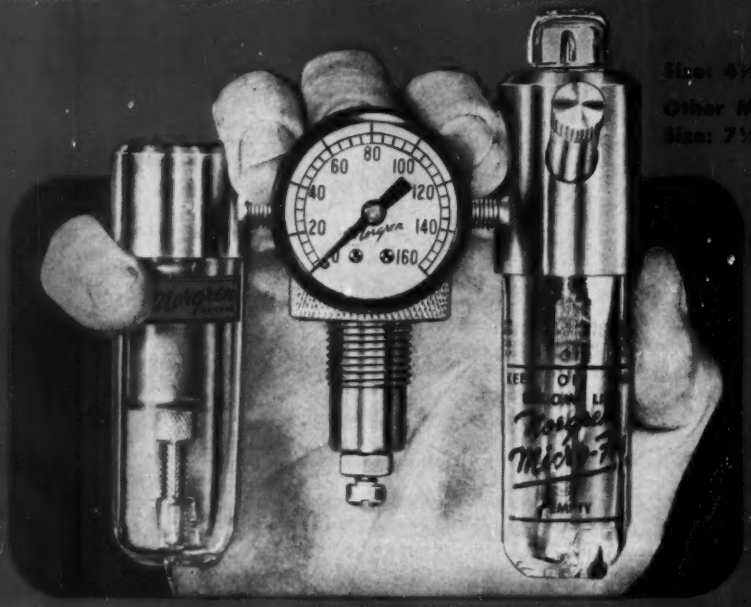
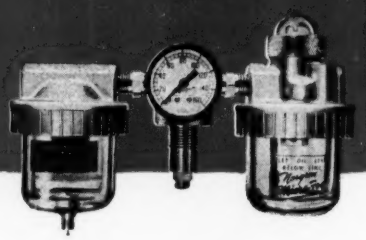
Where Space is Tight...



NEW SPACE SAVING

Norgren MICRO-FOG

Lubro-Control Units



Models Available for Air Flows from .05 to 20 cfm.

These new Norgren MICRO-FOG units: **1.** Provide highly efficient compressed air processing for air tools and other air operated devices. **2.** Provide efficient lubrication for bearings and machine tool components. Maximum operating pressure 150 psi, maximum temperature 120° F.

AIR LINE FILTERS

Two new air line filters provide efficient removal of liquids and solids from the air line, preventing damage to connected air equipment.

PRESSURE REGULATOR

A new small, compact pressure regulator is used for both series of Lubro-Control Units. It provides accurate, trouble-free regulation of the air pressure. Adjustable over a pressure range of 5 to 100 psi.

MICRO-FOG LUBRICATORS

New MICRO-FOG Lubricators provide efficient and adjustable lubrication for bearings, air tools, air cylinders and other air operated devices.

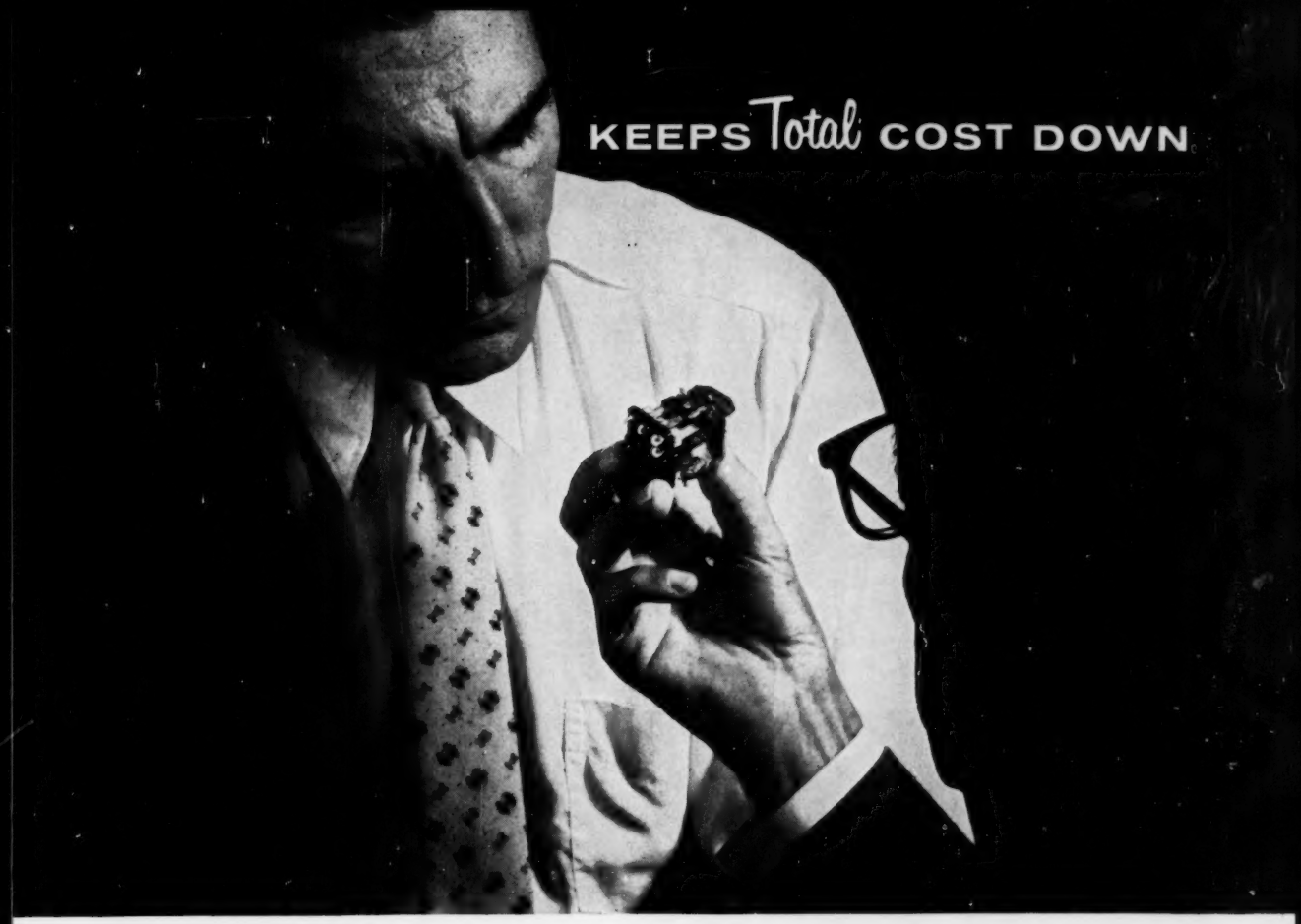
If it's Norgren... It's Dependable.

For complete information, call your nearby Norgren Representative listed in your phone directory, or WRITE for BROCHURE No. 915B

C. A. NORGREN CO.

3442 SOUTH ELATI STREET, ENGLEWOOD, COLORADO

Circle 470 on Page 19



IF INSTALLED-COST IS A DESIGN PROBLEM

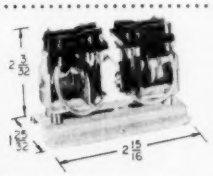
Look at the KA general purpose RELAY

What do your relays cost *installed?* Initial cost is never the whole story.

Our KA Relays are engineered for modern production methods. They're available with printed circuit, taper tab, quick-disconnect or hook solder terminals . . . are simple, economical to install. This fact, combined with low original cost, keeps your total cost down.

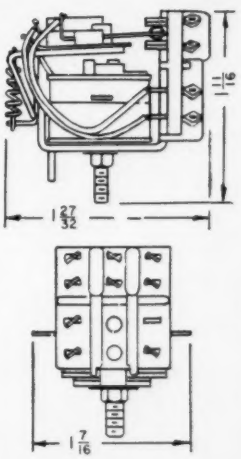
Another source for savings! All standard KA ac relays bear U/L and Canadian Standard Association seals of approval.

Write or call for more information or see the complete P&B catalog in Sweet's Product Design File.



KB LATCHING RELAY consists of two KA Relays, forming a mechanical latching relay, featuring a large number of contact arrangements.

KA ENGINEERING DATA



GENERAL:

Insulation Resistance: 100 megohms min.
Breakdown Voltage: 1500 V. rms between all elements.
Temperature Range:
−55° C. to +85° C. DC
−55° C. to +70° C. AC
Weight: 2.0 ozs.
Pull-In: DC 75% of nominal voltage.
AC 78% of nominal voltage.
Terminals: Taper tabs.
Printed circuit.
Quick-disconnect.
Pierced solder lugs.
Enclosures: Dust Cover
(max. 55° C. ambient for AC relays)
(max. 70° C. ambient for DC relays)

CONTACTS:

Arrangements: 3 Form C (3PDT) max.
Material: Movable—⅛" silver; stationary—$\frac{1}{32}$" wide silver overlay.
Load: 5 amps @ 115 V. AC 60 cps res.

COILS:

Resistance: 16,500 ohms max.
Power: 1.2 watts (DC), 2 volt amps (AC)
Duty: Continuous AC or DC (DC coils will stand 4.5 watts at 25° C.)

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

Circle 471 on Page 19

POTTER & BRUMFIELD

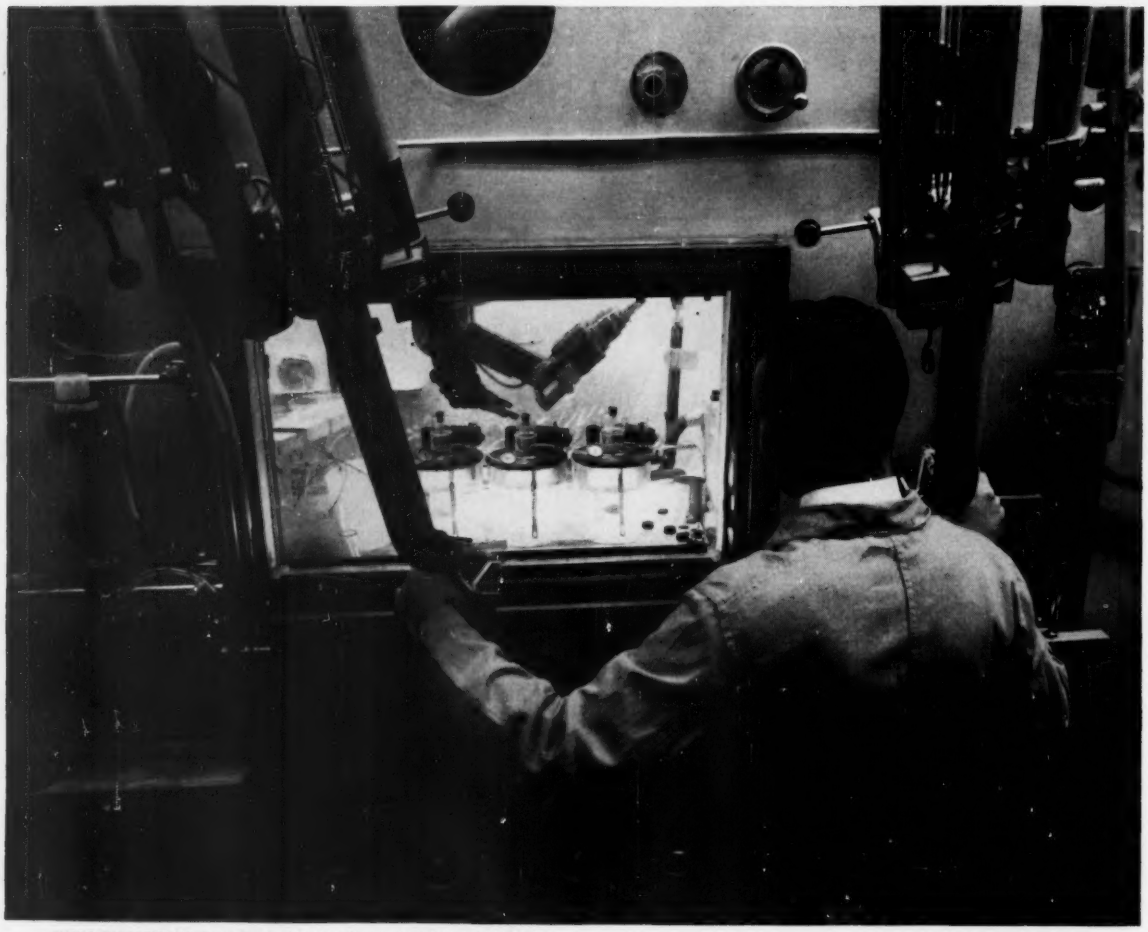
DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY, PRINCETON, INDIANA

IN CANADA: POTTER & BRUMFIELD CANADA LTD., GUELPH, ONTARIO

WHEN YOU WANT TO TOUCH THE UNTOUCHABLE

You may design manipulators for radioactive materials . . . control devices for corrosive chemicals . . . laboratory equipment for research on deadly viruses. *Whatever* you design, if it calls for precision instrument ball bearings, Fafnir can help you. Low torque, for example, is insured through Fafnir's balanced bearing and retainer design, extreme accuracy in geometry of parts, superior finishes, and "clean room" assembly. Let Fafnir's uniformly high standards of quality plus diversity of types, sizes, and materials help *you* "touch the untouchable" in meeting exacting requirements. The Fafnir Bearing Company, New Britain, Connecticut.

Fafnir precision instrument ball bearings are available in four tolerance classes—ABEC 1, 3, 7, and Modified 7—to meet specific needs.



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FAFNIR
BALL BEARINGS

UNIRING

SIMPLIFIES GROUNDING SHIELDED CABLE

INSERT braid and tap wire

CRIMP with the Burndy Hytool

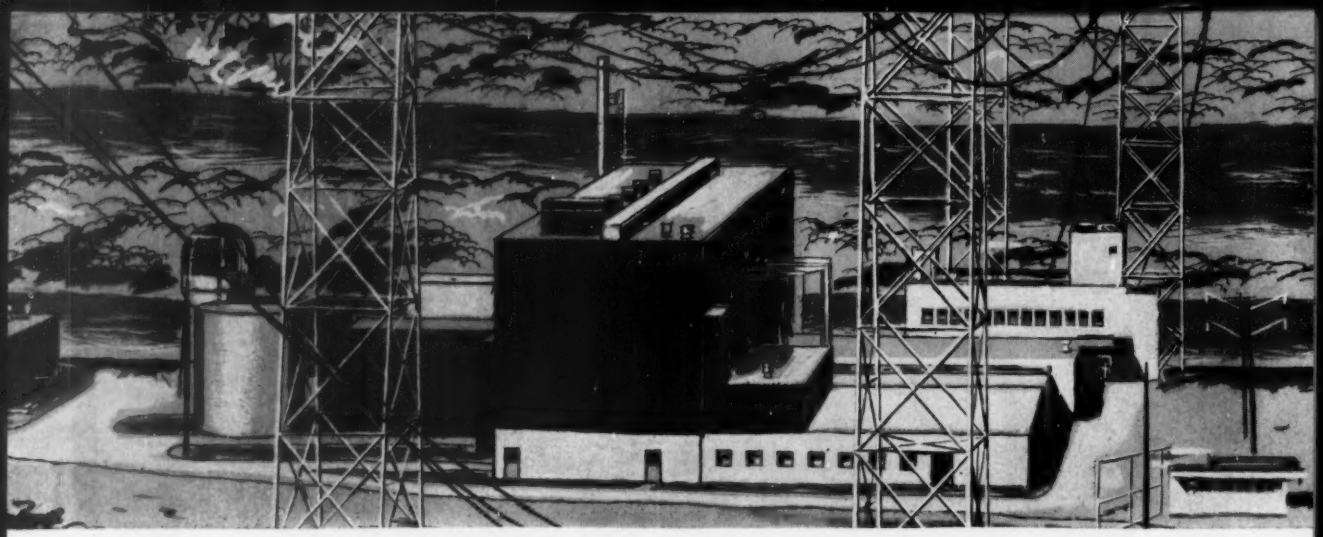
UNIRING connections are...**mechanically stable and reliable:** a single crimp completes a uniform, vibration-resistant, insulated connection—controlled by full-cycling color-coded tooling—no heat or burnt cable...**electrically stable:** low resistance, noise-free...space saving: only a few mils larger than cable diameter. For more details, call or write OMATON Division.

BURNDY

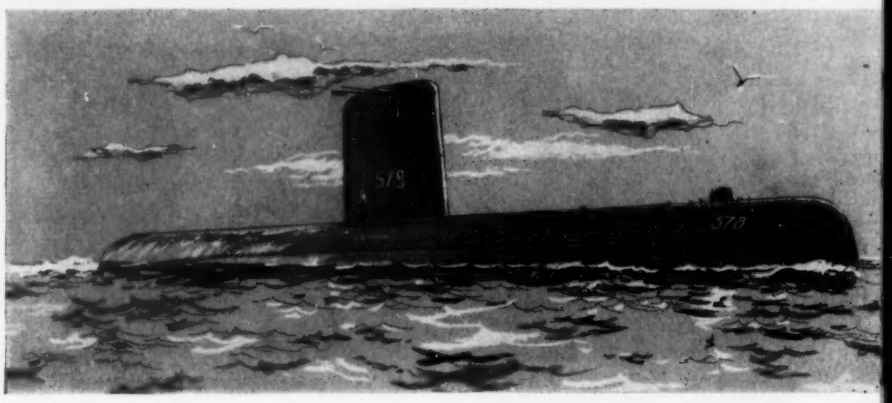
59-22

Norwalk, Connect. In Europe: Antwerp, Belgium Toronto, Canada

Circle 473 on Page 19

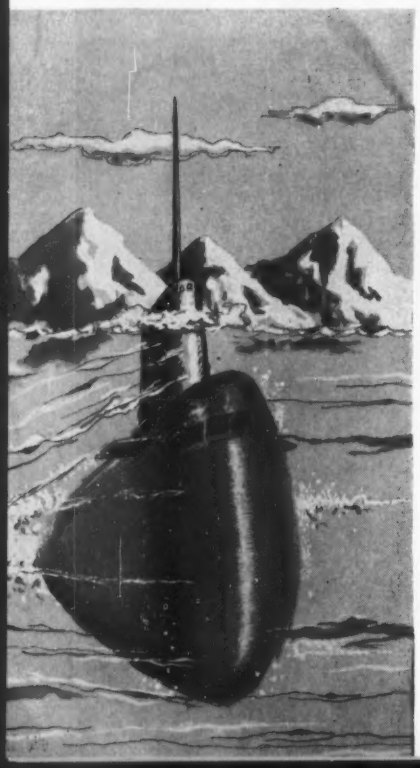


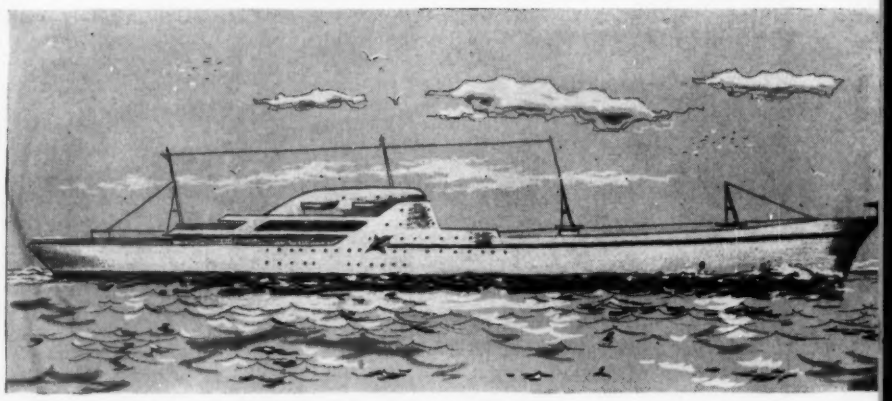
Shippingport Atomic Power Station—first United States full-scale central station atomic power plant devoted exclusively to civilian needs. First produced power on the line 12:39 A.M., December 18, 1957.



U.S.S. Skate—world's third nuclear-powered submarine. Crossed North Pole on August 11, 1958.

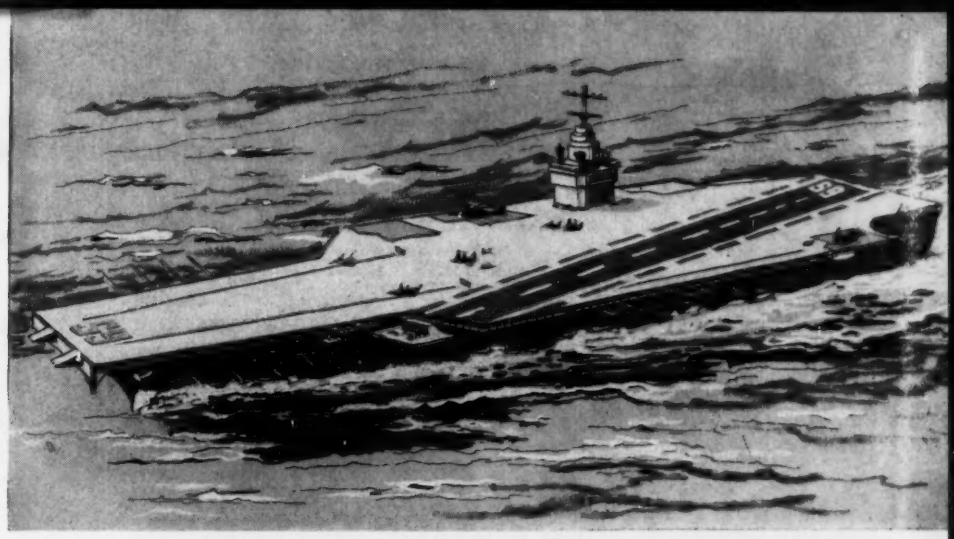
Next time you have a heating problem, remember...



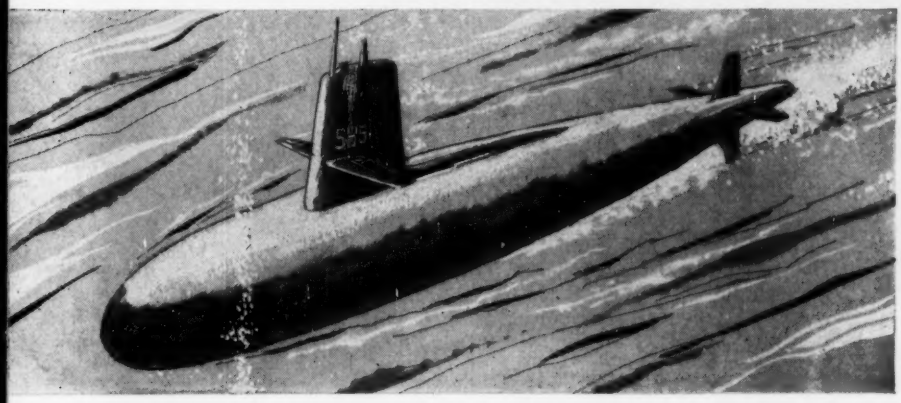


N.S. Savannah—world's first nuclear-powered merchant vessel. Launched July 21, 1959.

U.S.S. Nautilus—world's first nuclear-powered submarine. Completed first transpolar voyage August 5, 1958.



Enterprise — world's first nuclear-powered aircraft carrier. Now under construction.



U.S.S. Skipjack—world's most maneuverable submarine. Sea trials completed March 10, 1959.

CHROMALOX Electric Heat *solved* heating problems for all these projects

Heaters are installed in the primary systems of pressurized-water-type nuclear reactors to maintain the desired pressure control. *Each of the nuclear power projects illustrated uses hundreds of special Chromalox electric cartridge type heaters for this purpose.*

Chromalox electric heaters handle many other heating jobs in these projects. On the Nautilus, for example, fourteen different types of Chromalox heaters are used . . . for such applications as comfort heating, de-icing, maintaining lubricating oil temperatures, purifying air and water and cooking food.

Chromalox was first to make electric heating practical. Today, Chromalox has the world's most complete electric heating line, the largest stock and a nationwide network of Sales Engineering Representatives. Your Chromalox Man has the answers to *your* industrial, residential or commercial heating problems.

The Chromalox Library contains information on more than 15,000 different types, sizes and ratings of electric heaters and heating elements. Give us a brief outline of your problem and we will send you literature on heaters to do the job.

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INDUSTRIAL • COMMERCIAL • RESIDENTIAL
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7500 Thomas Boulevard • Pittsburgh 8, Pa.

Circle 474 on Page 19

S. S. White DRIVE AND CONTROL IDEAS FOR ENGINEERS

Tips on better designing with flexible shafts

More Savings with Ready-to-Attach S. S. White Standard Flexible Shafts

NEW, EXTRA-HEAVY-DUTY SHAFT ADDED TO "OFF-THE-SHELF" LINE

Here's a time and money saving idea... the majority of flexible shaft needs can be met with ready-to-attach S. S. White **standard** flexible shafts.

This line has been recently expanded by the addition of the .500" dia. standard shaft to handle extra-heavy loads.

Flexible shafts allow you to simplify design ... position controls and driven parts to best advantage... eliminate expensive gears, universals, rods and costly alignment problems.

S. S. White **standard** flexible shafts are low in cost and readily available because they are **stock** items. They save you engineering time because the designing has already been done for you by S. S. White, first name in flexible shafts. **They come complete and ready to attach directly to your mating spindle.**

Another plus! Convenient, low-cost, readily available, S. S. White standard flexible shafts are the ideal way to test the advantages of flexible shafts in your products.

Where to use S. S. White Standard Flexible Shafts

REMOTE CONTROL of valves, actuators, switches, indicators and other mechanical or electrical equipment. S. S. White standard remote control flexible shafts come in four different shaft diameters to handle a wide range of requirements.

POWER DRIVE for an endless variety of applications ... portable tools, instrument drives, machine tools, pumps ... anywhere the designer needs to transmit power around obstructions or to movable parts, by means of a single, self-contained, easily applied unit. Four standard sizes.

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Selection of S. S. White standard flexible shafts: complete description and application data available. **Write for bulletin 5801.**

WRITE FOR COMPLETE DATA!

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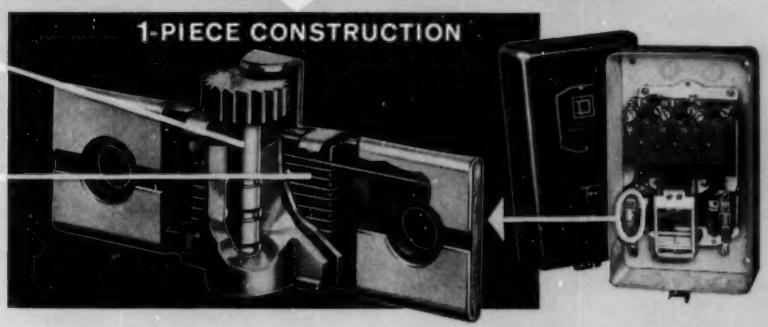
When you buy Motor Starters --

YOU PAY FOR OVERLOAD PROTECTION

...BE SURE YOU GET IT!



Heat-responsive element (solder pot) provides accurate response to overload, yet prevents nuisance tripping.

Heat-producing element is an integral part of overload unit. It's permanently joined to solder pot, can't become misaligned.

Only ONE-PIECE Overload Relays can give 100% Protection Only with ONE-PIECE construction can you *know* you've installed the heater correctly. Only with ONE-PIECE construction can you *know* the heater is exactly centered, or properly positioned, so that it performs according to its rating. Only with ONE-PIECE construction can you *know* your starters will not operate without the thermal units properly installed. Only with ONE-PIECE construction can you *know* your motors have full protection.

Only Square D has ONE-PIECE Construction ONE-PIECE construction *eliminates* any possibility of heater misalignment. Square D melting alloy thermal overload relays can be installed only one way. They are tamper-proof. They are factory-assembled, are *individually* calibrated and tested. Repeated tripping will not affect their accuracy.

Insist on Square D starters with melting alloy thermal overload relays

Let your Square D Field Engineer show you 1 how one-piece construction is accomplished and how easy it is to mismatch separate heaters and solder pots— 2 an endurance tester to prove that overload units can be reset repeatedly without damage while the solder is liquid — 3 a tripping time tester to compare various types of melting alloy units and to prove that tripping time won't change after repeated operation.

Individual factory inspection of every Square D melting alloy thermal overload relay means performance you can trust. Each unit is calibrated and thoroughly tested to make sure it will perform according to its rating.

Write for Bulletin SM-275 for the complete story on Square D starters with ONE-PIECE thermal overload relays. Address Square D Company, 4041 N. Richards St., Milwaukee 12, Wisconsin

SQUARE D COMPANY

THE VARIETIES OF HONEYCOMB

#6 CELL GEOMETRY The cell geometry, or configuration, of honeycomb is determined during manufacturing by the basic method of production. Two honeycomb production techniques are in use today: expansion and corrugation.

Expanded Honeycomb

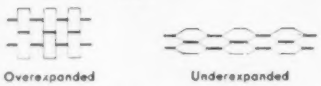
The material for the honeycomb—pre-impregnated fiber glass cloth, aluminum alloy foil, paper, or other web materials—is fed from rolls into special high-precision machinery, where continuous stripes of structural adhesives are applied to the web. This web is then folded or cut into sheets and stacked in such a manner that the resulting bonded stack can be expanded to form hexagonal cells. Before expansion the stack is cured to set the node bond adhesive.

Figure 1 illustrates a stack, called HOBE® for HOneycomb Before Expansion, in a compressed condition and the resultant geometry under normal expansion.

Fig. 1

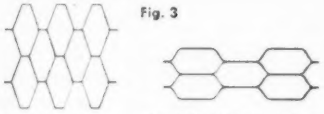
Expansion is normally stopped when the characteristic hexagonal-shaped cells are formed. By varying the degree of expansion from partial expansion to full overexpansion, virtually unlimited adjustment of the web area to volume relationship may be obtained. Figure 2 illustrates variations in cell geometry resulting from controlled expansion.

Fig. 2



By varying the width and location of the adhesive stripes, a number of other cell configurations are possible, such as those shown in Figure 3.

Fig. 3

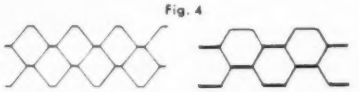


Corrugated Honeycomb

The material for corrugated honeycomb—aluminum alloy, stainless steel, titanium, and others—is pre-corrugated to the desired configuration. Precision equipment then joins the corrugated material at the node point with a resistance weld or an adhesive connection.

The corrugating technique is used principally for welded honeycomb products with the characteristic square-cell configuration shown in Figure 4. Corrugation is also adaptable to materials, foil gauges, or adhesive systems that do not lend themselves to the expansion process.

Fig. 4



MATERIALS The designer can call upon an extremely wide range of honeycomb materials to meet individual design problems.

Metallic Honeycombs

In standard production are aluminum alloys 3003 and 5052 and such stainless alloys as 17-7PH, PH15-7Mo, AM 350 and 355. Special production includes aluminum alloy 5056, a wide variety of stainless alloys, and exotic metals such as tantalum, molybdenum and titanium. Experimental work also continues on copper and carbon steel.

Non-Metallic Honeycombs

In standard production are non-impregnated Kraft paper and glass-fabric impregnated with phenolic resins, polyester resins and special heat-resistant phenolics. Special production includes phenolic impregnated Kraft paper and impregnated asbestos webs. In addition, experimental work continues on silicone, phenylsilane, rubber, and a number of sheet plastics.

Sizes and Shapes

Standard production cell sizes vary from $\frac{1}{8}$" to $1\frac{1}{2}$". Core materials have been produced with cell sizes as small as 1/32" and as large as 3". Cell depths up to 24" and piece sizes up to 48" x 96" are available in some materials. Available in flat panels of close tolerance thickness or block form, as well as finished carved and contoured core assemblies, honeycomb offers a broad variety of configurations, materials, sizes and shapes to open even broader areas of potential application.

Others in this series. Copies sent on request.

1. **Honeycomb Sandwich Panels**
2. **Honeycomb Sandwich Materials**
3. **Successful Honeycomb Sandwich Design**
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* Trade Mark.

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World leader in honeycomb

Executive Offices: 2332 Fourth Street, Berkeley 10, Calif.
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Circle 477 on Page 19

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Miller

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HYDRAULIC CYLINDER LINE

JOB RATED, MODEL " J "

BORE	SEVERE OPERATING CONDITIONS	MODERATE OPERATING CONDITIONS	YOU SAVE THIS % IN PRICE OVER STANDARD 2000-3000 PSI CYLINDERS
1½"	1500 PSI	2500 PSI	27%
2	1500	2500	27%
2½	1000	1500	28%
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4	1000	1500	35%
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8	500	800	50%
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12	500	800	76%
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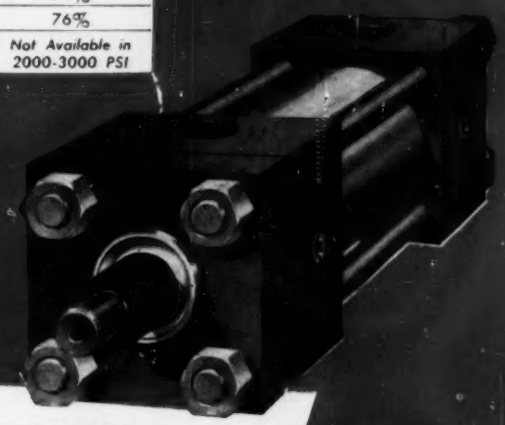
with ***IDENTICAL*** *seals, design, and safety factors as the famous Miller "Power-Packed" Model "H" Line for 3000-5000 psi service.*



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1. *No seal made of synthetic rubber is compatible with even 50% of available, commercial, petroleum base hydraulic fluids.*

MILLER Uses All Teflon* Seals to Eliminate External Oil Leakage because Teflon is impervious to all known hydraulic fluids, even fire-resistant types.

TEFLON SHEF SEAL At Tubing Ends

No blind assembly. Is
Shear-proof
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Tetion rod flange seal requires no adjustment. Teflon bushing seal is shearproof. Teflon wiper keeps dirt out.

TEFLON Seals On Ball Check And Adjusting Screw

Non-protruding, self-locking, cushion adjusting screw interchangeable with ball check for easy access.

MILLER Uses Resin-Impregnated Leather Piston Cup Seals because they are compatible with petroleum base fluids and some fire-resistant types. Teflon cups available at small extra cost.

2. *Nicked or scored piston rods cause seal failure*

MILLER Uses Case-Hardened Chrome-Plated Piston Rods because they prevent nicks, scoring and rust.

NOW! . . . You can save MORE with quality Miller "Job-Rated" Cylinders than with cut-price, lesser quality hydraulic cylinders. And the "Job-Rated" Cylinders are also available under the same immediate shipment program as the Power-Packed Line (2 hours if necessary—3 days normal).

* Du Pont trademark for tetrafluoroethylene resin which withstands temperatures from −120° to +300° F. and all hydraulic fluids

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H HEAT PROOF
E EXTRUSION PROOF
F FLUID PROOF
SEAL
Teflon Pressure Energized
Hydraulic Cylinder Tubing End Seal
PAT. APPLIED FOR

OTHER MILLER QUALITY FEATURES

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Circle 478 on Page 19

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DIVISION OF FLICK-REEDY CORPORATION
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AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS

Memo on Metals

Crucible Alloy Offers High Impact Strength, Hardness at 220-240,000 psi Strength Levels

Today's ultra-strength steels possess a unique combination of mechanical properties even when they are used at their ultimate levels of tensile strength. One of the first steels developed in this class — Crucible HY-Tuf® — combines high impact strength, hardness and good ductility at the 220,000/240,000 psi range.

HY-Tuf (1.8% Ni, 1.30% Mn, 1.50% Si, 0.40% Mo) was first widely used in aircraft applications because of its favorable strength-weight ratio. But, because it is also tough and hard, it has rapidly found its way into power-driven garden tools, hand- and power-operated banding machines, rock bit bodies, cutter head bolts, couplings, pinion gears and shafts.

HY-Tuf's high impact strength, especially at high levels of tensile strength or hardness, has been demonstrated in a great number of tests. These tests prove HY-Tuf definitely superior to standard AISI alloy steels in impact strength and ductility at hardnesses above 42 Rc or tensile strengths above 190,000 psi. For specific comparisons, see Figures A and B.

FIG. A—TENSILE AND IMPACT DATA

Grade	Temper	Rc	Tensile Strength, psi	.2% Yield Strength, psi	.01% Yield Strength, psi	% Elong. in 2 in.	% Red. of Area	Izod Impact Ft-Lb
HY-Tuf	550F	46.5	234,000	193,000	154,000	13.1	49.7	31
4340	700	46	228,000	212,000	210,000	11.2	47.8	17
4140	800	46	227,000	205,000	198,000	11.2	39.4	8
9442	700	46	225,000	203,000	200,000	10.3	43.4	11

Oversize .505" dia. tensile specimens and finish machined Izod specimens were oil quenched from the conventional austenitizing temperatures and tempered as indicated.

FIG. B—MAXIMUM IMPACT PROPERTIES
(at hardness of Rockwell C45 or greater)

Grade	Izod			Tension Impact			
	Ft-Lb	Temper	Rc	Ft-Lb	Elong.	Temper	Rc
HY-Tuf	33	400F	47.5	195	16	None	47.5
4340	13	860	45	158	12.2	400F	55
4140	17	500	52	160	14	375	55
8630	19	400	51	148	14	200	52.5
4130 (oil)	17	500	47.5	133	14.5	200	50
4130 (water)	21	450	50	142	13.0	200	52.5

The alloy's superior ductility is shown by these slow bend tests performed on ⅞" rod bars heat treated to 47 Rc.

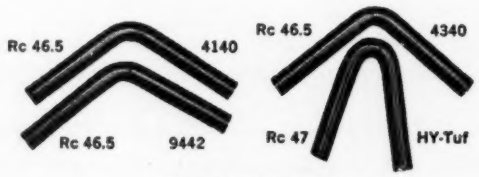
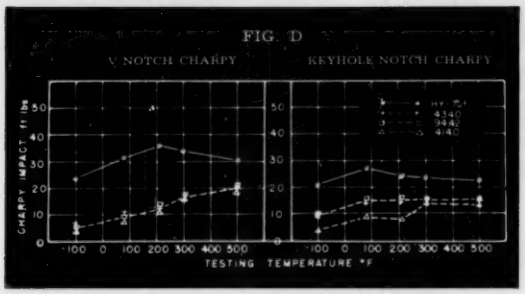


FIG. C—BEND TESTS
Bars — ⅞" rd.

HY-Tuf's notch sensitivity is much lower than that of conventional steels at hardnesses of 45 to 47.5 Rc. Unlike other alloys, HY-Tuf has higher impact values for the V-notch Izod test than for the keyhole Charpy test. This is important because it means that HY-Tuf is much less sensitive to a notch at high strength levels than ordinary steels.

Crucible HY-Tuf conforms to MIL-S-7108 and AMS 6418 and is available in commercial sizes and quantities. For more information on this ultra-strength alloy, send the coupon.

* *ultra-strength steel's impact strength, hardness*
* *titanium price reductions*
* *permanent magnet handbook*



Effect of testing temperature on the notch impact values of HY-Tuf and conventional steels heat treated to 47 Rc.

New Low Prices of Titanium Mill Products Justify Using The Alloy in More Applications

Early this year Crucible's Titanium Division announced new price reductions for its titanium mill products – that cut these prices to *a new industry low*. The reductions, as much as 25%, affected both base prices and the costs of "extras".

For example, sheet was cut from $9.10 per pound base price to $7.75. Strip was reduced $1.25 per pound to $7.25. Plate, formerly $6 per pound, now costs only $5.25. Crucible also slashed billet prices to $3.55 per pound and wire to $5.75 per pound. Bar items were reduced $1.00 per pound to $4.25 (base price). In addition, some size "extras" were reduced as much as 55%, and finished "extras" by over 40%.

Because of these lower prices, engineers can now utilize titanium's unique properties in many more applications and justify the selection economically. (Even at previous prices, titanium often proved itself the low-cost metal on a cost-per-service-year basis.) This should prove especially true in processing applications requiring corrosion resistance and long-service life, and in aircraft and missile applications where high-strength, lightweight materials are essential.

During the past five years, titanium fabricating costs have also been cut substantially because of experience gained in forging, machining, welding and forming. *For detailed information on Crucible titanium mill products, send the coupon.*

Permanent magnet handbook: 346 pages of design data

One of the most comprehensive manuals ever published on permanent magnets is available through Crucible Steel Company.

The *Permanent Magnet Handbook* contains all the data needed to design magnets into generators, meters, compasses, chucks, couplings, hi-fi and television components, and thousands of other products. It also contains entire sections on permanent magnet measurements, ferromagnetism, magnetization, demagnetization and electro-magnetic theory. It gives the complete performance and property data of over 60 different magnet materials: such as, magnet steels, Alnico alloys, and Ferrimag ceramics.

To cover actual printing costs, a nominal sum of $10.00 is being charged for each copy. However, this sum also covers the cost of additions to the handbook – mailed to subscribers each time new Crucible data become available.

For your copy, send the coupon and check or money order for $10.00. If you are located in Pennsylvania, add 35¢ for state sales tax.

CRUCIBLE STEEL COMPANY OF AMERICA
Dept. EL-07, The Oliver Building
Mellon Square, Pittsburgh 22, Pa.

Gentlemen:
Please send me the following:

1. Crucible HY-Tuf Data Sheet ☐
2. Further information on titanium mill products ☐
3. Permanent Magnet Handbook (Enclose check or money order) ☐

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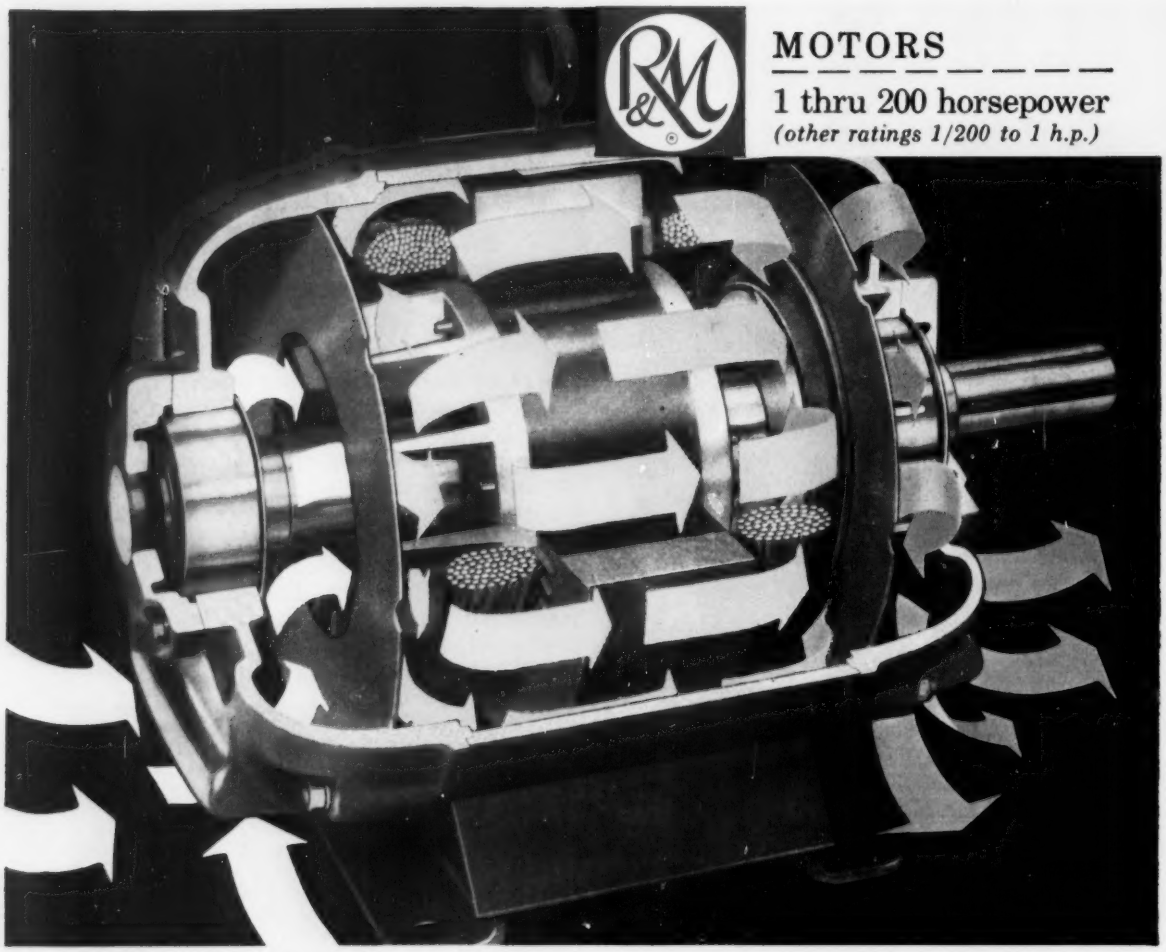
CRUCIBLE STEEL COMPANY OF AMERICA



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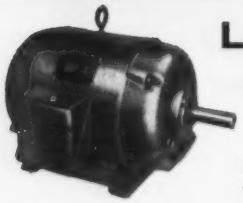
1 thru 200 horsepower

(other ratings 1/200 to 1 h.p.)



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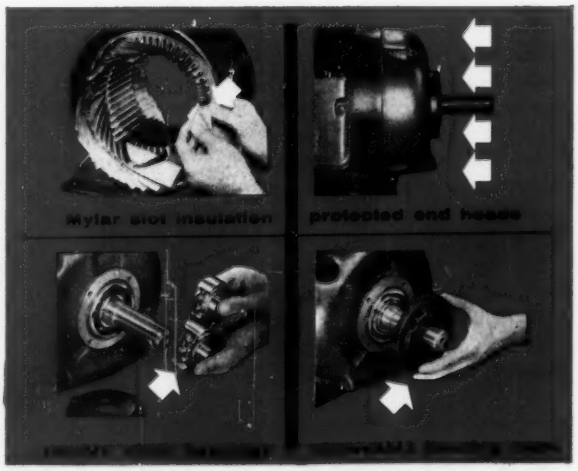

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thermal thicket

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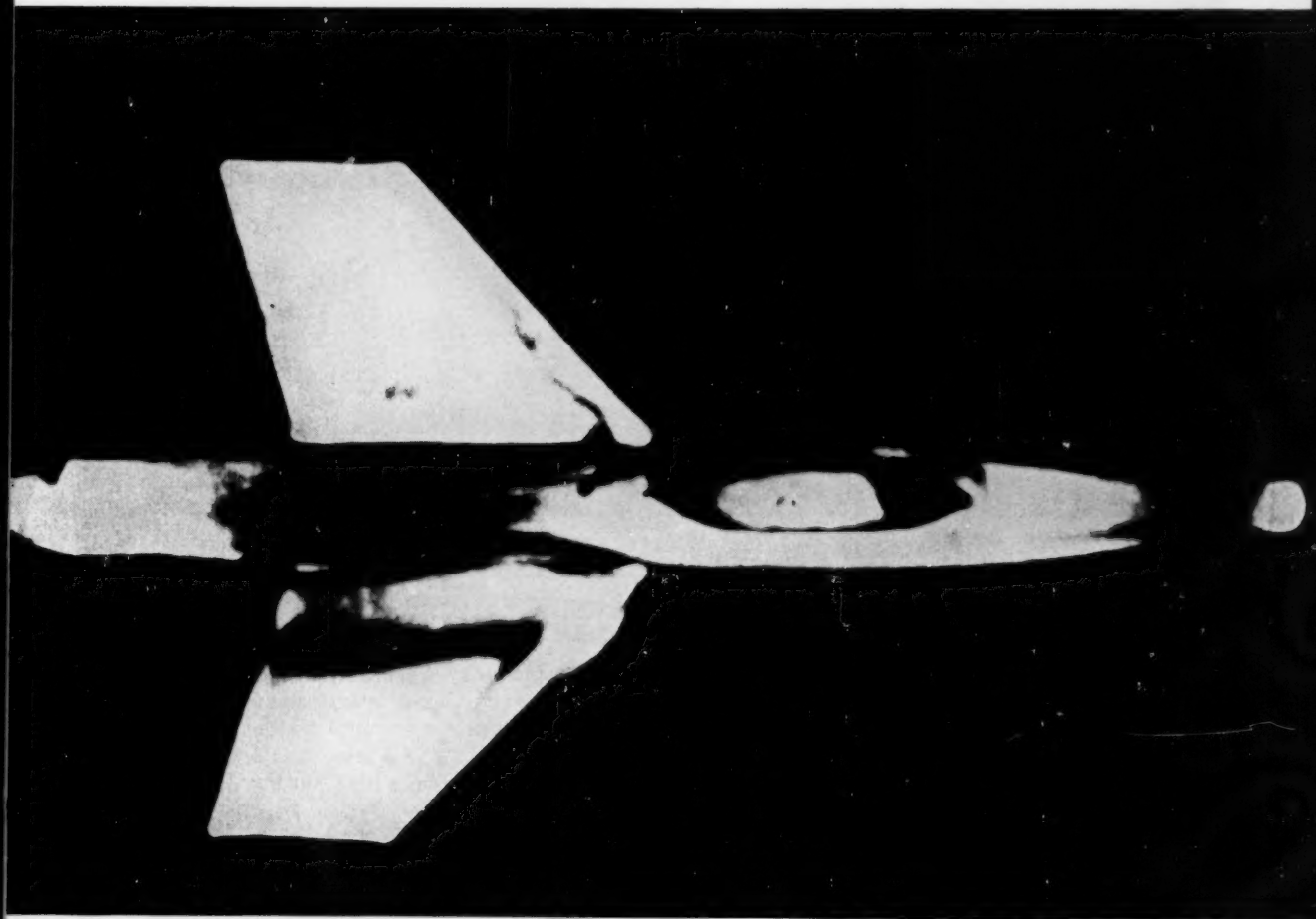
Needed: *Dependable high temperature alloys for structural components.*

Solution: *Find the right alloys that are easy to forge and machine and are truly uniform.*

Source: *Predictable performance Carpenter alloys made by the exclusive Mel-Trol, VacuMeltrol and Consumet melting processes.*

Engine builders find them ideal for many critical parts. Forge shops report improved forgeability resulting in better finishes requiring far less machining. Work goes faster. Rejects are fewer.

Call your local Carpenter Representative for the whole story about predictable performance alloys and how they can benefit you. The Carpenter Steel Company, Reading, Pa.



Carpenter steel

The Carpenter Steel Company, Main Office and Mills, Reading, Pa.
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Circle 481 on Page 19

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the performance-proven hydraulic oil

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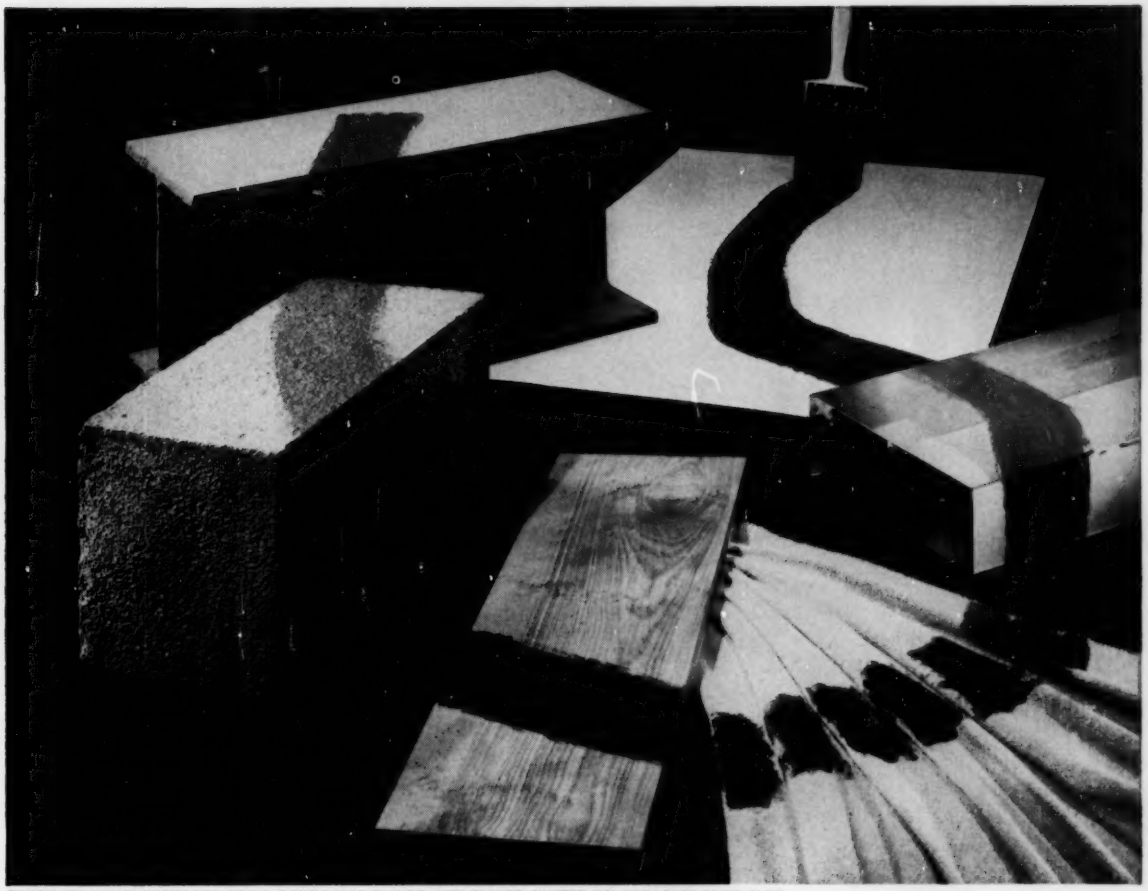
Circle 482 on Page 19

NEWEST WEAPON IN THE WAR AGAINST CORROSION AND ABRASION!

Coro-Gard® 1706

BRAND PROTECTIVE COATING



PROTECTS MOST SURFACES FROM CORROSIVE FLUIDS AND FUMES, WATER OR ABRASIVE PARTICLES

From the Research Laboratories of 3M comes a remarkable new coating to fight corrosion—CORO-GARD 1706 Brand Protective Coating. This neoprene rubber based coating air-cures to a tough, rubbery, protective film with exceptional resistance to corrosive fluids and fumes, water and abrasion. It maintains exceptional adhesion, flexibility, corrosion and abrasion resistance even after these strenuous test conditions: 2000-hour salt-spray attack; 20 weeks' submersion in 20% solution of hydrochloric acid; six-month weather exposure in Miami, Florida.

CORO-GARD 1706 Coating speeds production, provides unusually high coverage to cut costs. It brushes as easily as paint, is self-priming, yet goes on vertical surfaces with minimum sagging. For steel, aluminum, wood, concrete, cloth and some plastics—wherever corrosion or abrasion must be fought—specify new CORO-GARD 1706 Coating. It provides maximum protection at low cost.

For complete performance data without obligation, write today on your company letterhead to: AC&S Division, 3M Company, Dept. SAR-129, St. Paul 6, Minn.

"Coro-Gard" is a reg. TM of 3M Co.

ADHESIVES, COATINGS AND SEALERS DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

...WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

ANOTHER IN A SERIES
OF MOTOR FACTS
FROM ALL INDUSTRIES

"Roughest duty we have ever seen motors endure"

reports Marquette Iron Mining Co. of the Westinghouse Life-Line A motors in its Eagle Mills Pelletizing Plant

Operating continuously, 24 hours per day, dependable Westinghouse Life-Line® "A" motors drive a network of fans and conveyors at the Eagle Mills Pelletizing Plant of Marquette Iron Mining Co., Ishpeming, Michigan.

Some of these motors are located directly above a sintering machine where ambient temperatures often exceed 200° F and the motor is subjected to deposits of finely divided iron ore. Under these conditions, not a single motor breakdown or failure has occurred during 11 months of service.

Says Mr. Ed Gagnon, plant electrician, "Our Westinghouse motors have given us complete reliability on the roughest tests we have ever seen a motor endure."

For specific information about the ways your operation can benefit from the improved performance, longer life and reduced maintenance offered by the dependable Life-Line "A," contact your nearby Westinghouse sales engineer. Or write to Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania. J-22077

YOU CAN BE SURE...IF IT'S Westinghouse

Deposits of powdered iron ore are no problem to this 2-hp Life-Line "A" motor driving conveyor which carries powdered iron ore to the balling disc where ½" pellets are formed. Presealed, prelubricated Life-Line "A" bearings keep dirt and other material out.

Circle 484 on Page 19

Announcing a major breakthrough in computer programming.

If you've learned algebra, you can learn LGP-30 programming in just one day with

ACT 1

Algebraic Compiler and Translator

LGP-30

Electronic Digital Computer

The simplest, most economical compiling routine yet developed, ACT 1 now joins with the powerful Royal Precision LGP-30 to give you an unbeatable combination – low-cost, versatile general purpose electronic computation *and* programming.

With only a basic knowledge of mathematics, you can teach yourself ACT 1 in a single day. You can then submit any problem to the computer in simple algebraic form.

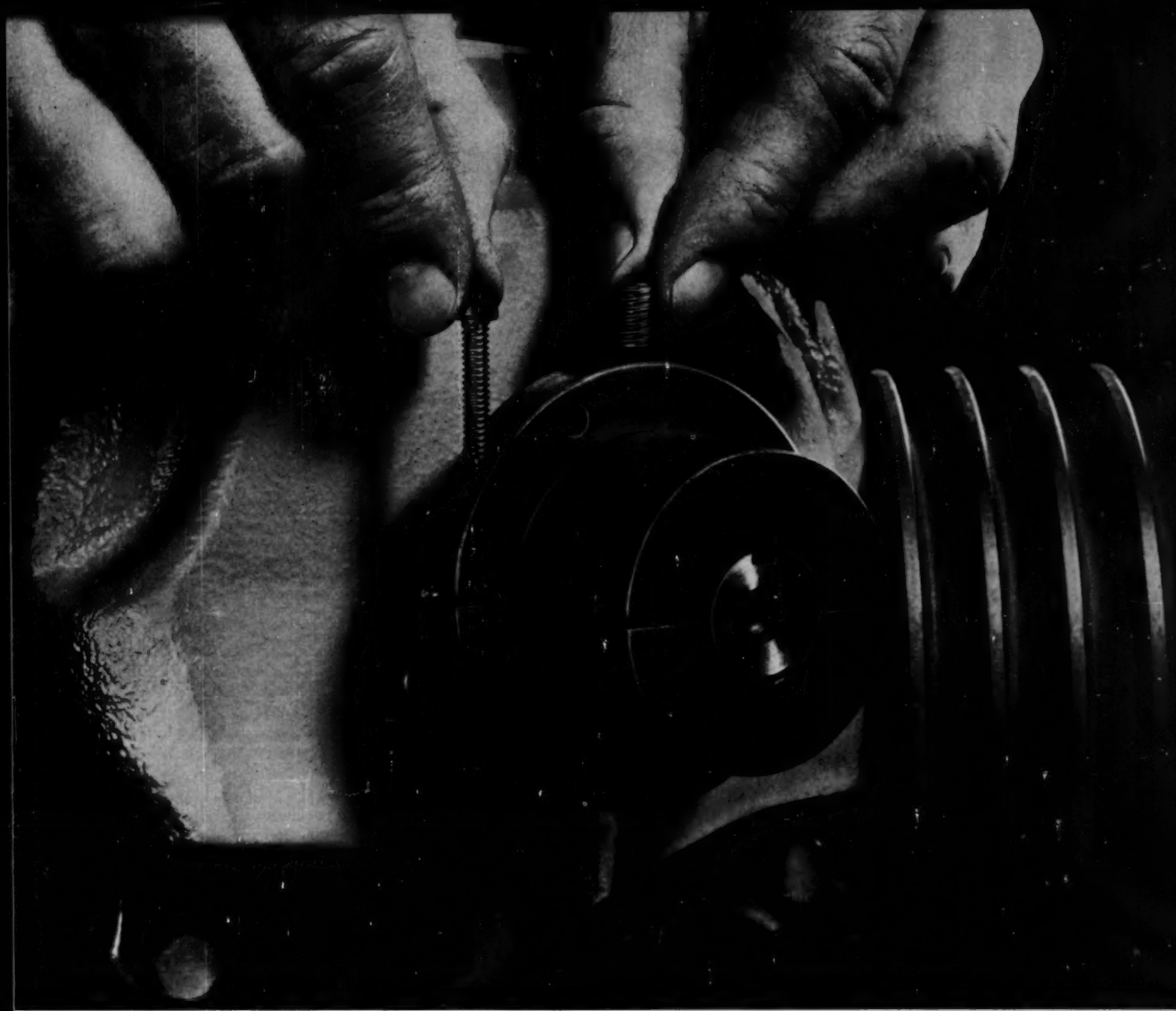
ACT 1 translates from a language you know into the machine language of the LGP-30. ACT 1 need not remain in the LGP-30 at compute time–giving you the entire computer memory (4096 words) for useful calculation. Both compiling and computing times are very rapid. Because the machine language program is punched on tape, it can be automatically brought into the computer whenever required.

Capable of compiling a fixed and/or floating point program for the LGP-30, ACT 1 vastly reduces programming time, gives you final solutions *faster than ever!* It is by all odds the simplest compiler to learn *and* to use.

We will be happy to send you the ACT 1 compiling routine free of charge. Write today to Royal McBee Corporation, Data Processing Division, Port Chester, New York.

Royal Precision Corporation

Royal Precision is jointly owned by the Royal McBee and General Precision Equipment Corporations. LGP-30 sales and service are available coast-to-coast, in Canada and abroad through Royal McBee Data Processing offices. For complete information on the LGP-30 write **ROYAL McBEE CORPORATION,** data processing division, Port Chester, New York



Announcing Worthington QD Sheaves with the

GOLDEN SCREWS

To demonstrate to you that the exclusive two-screw design is practically worth its weight in gold, all Worthington QD (Quick Detachable) sheaves now have two golden screws.

The clamp screw simplifies installation and assures permanent alignment. You can install QD sheaves one part at a time. No heavy rim and hub combination to delicately inch into place. You just slide the hub on the shaft and permanently lock it in position with the clamp screw. Then you slide the sheave rim into position on the hub. This job is simplified because you engage the large end of the sheave with the small end of the hub. To change speed you simply install another sheave on the hub which remains anchored to the shaft by the clamp screw.

The set screw prevents "key drift." It locks the key securely in place, avoiding the danger of the key drifting off and becoming a safety hazard. This feature is appreciated by plant operators who first brought this potential danger to Worthington's attention.

You tighten the set screw without distorting the hub. The clamp screw allows you to locate the hub on the shaft. The locked hub then permits you to tighten set screw on key without distortion.

You can get Worthington QD sheaves anywhere in the U.S. More than 350 distributors carry Worthington sheaves and Worthington-Goodyear Green Seal V-belts. For your copy of a 100-page Multi-V-Drive Manual on how to select the right sheave and V-belt write to Worthington Corporation, Section 79-15, Oil City, Pennsylvania. In Canada: Worthington (Canada) Ltd., Brantford, Ontario.

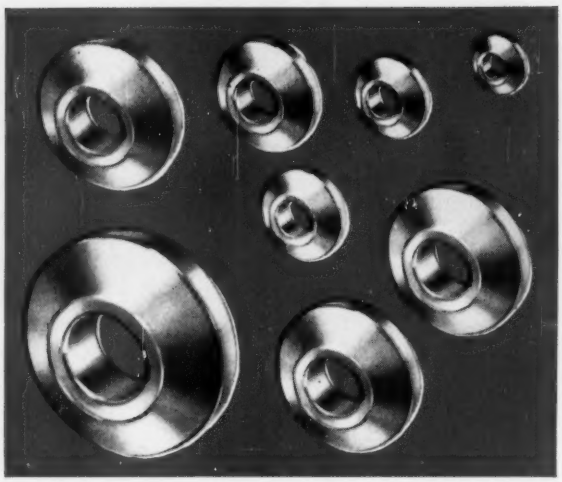
Circle 486 on Page 19

WORTHINGTON

35 MILLION BEARINGS...

and every one has given perfect performance!

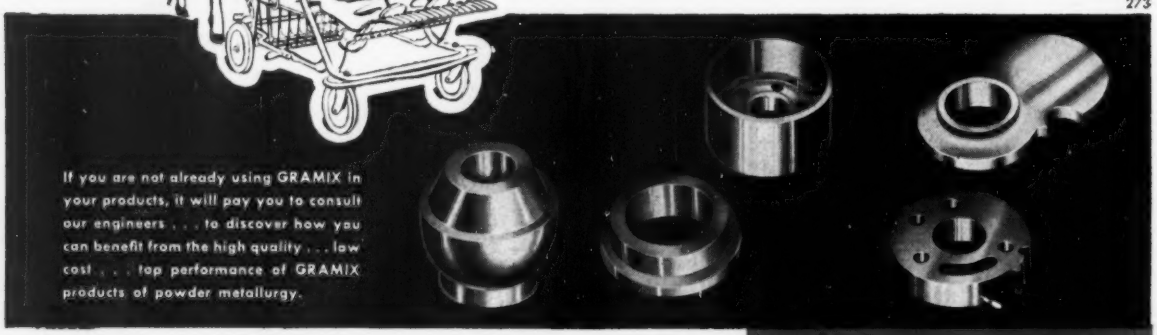
that's the record of GRAMIX® bearings in the famous TAYLOR-TOT® SLEEPER WALKER-STROLLER



Where there are youngsters, there are Taylor-Tots . . . and where there are these familiar sleeper walker-strollers there are GRAMIX bearings . . . in fact, 35 million to date have been shipped to the Frank F. Taylor Company of Cincinnati and have been accepted by their receiving inspection department without a single rejection. The strength, durability and resistance to wear of these GRAMIX bearings, two of which are used in each wheel, help give Taylor-Tot easier steering and handling. Even though Taylor-Tot strollers are run through snow, dirt and many times are left out in adverse weather, GRAMIX bearings provide the maximum in quietness, free running and long life.

GRAMIX is the ideal bearing material because it can be oil-impregnated for self-lubrication, requires no machining and is completely dependable.

273



If you are not already using GRAMIX in your products, it will pay you to consult our engineers . . . to discover how you can benefit from the high quality . . . low cost . . . top performance of GRAMIX products of powder metallurgy.

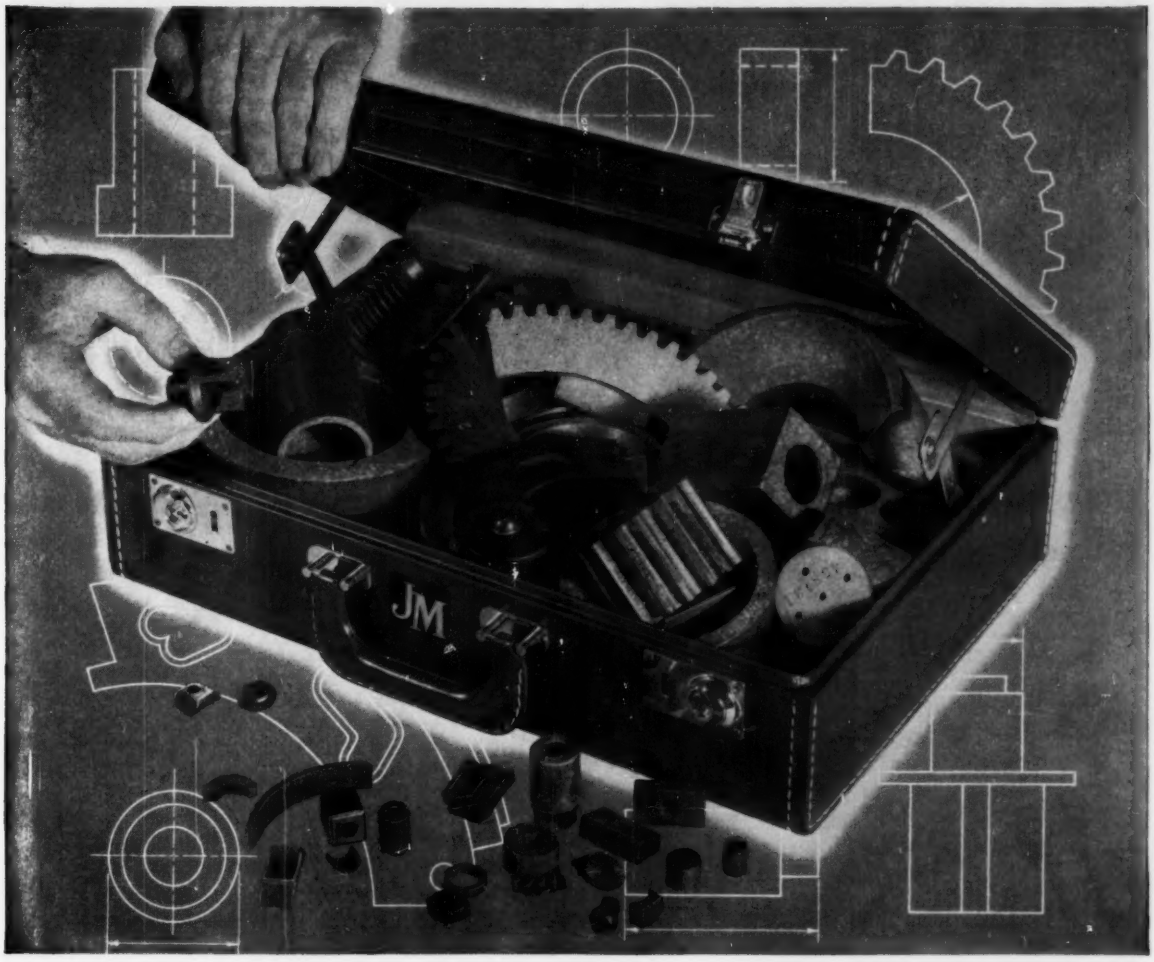
Write today for Engineering Bulletin No. 18, which covers design and metallurgical requirements and alloy selection of GRAMIX bearings. ▶

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 7, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

When it's time to pick the best friction materials for your latest clutch or brake design



The J-M Friction Specialist is a good man to have at your side!

No one friction material can possibly handle all motion control needs. That explains the wide latitude the J-M product line offers you when it's time to select frictions to suit *your* design.

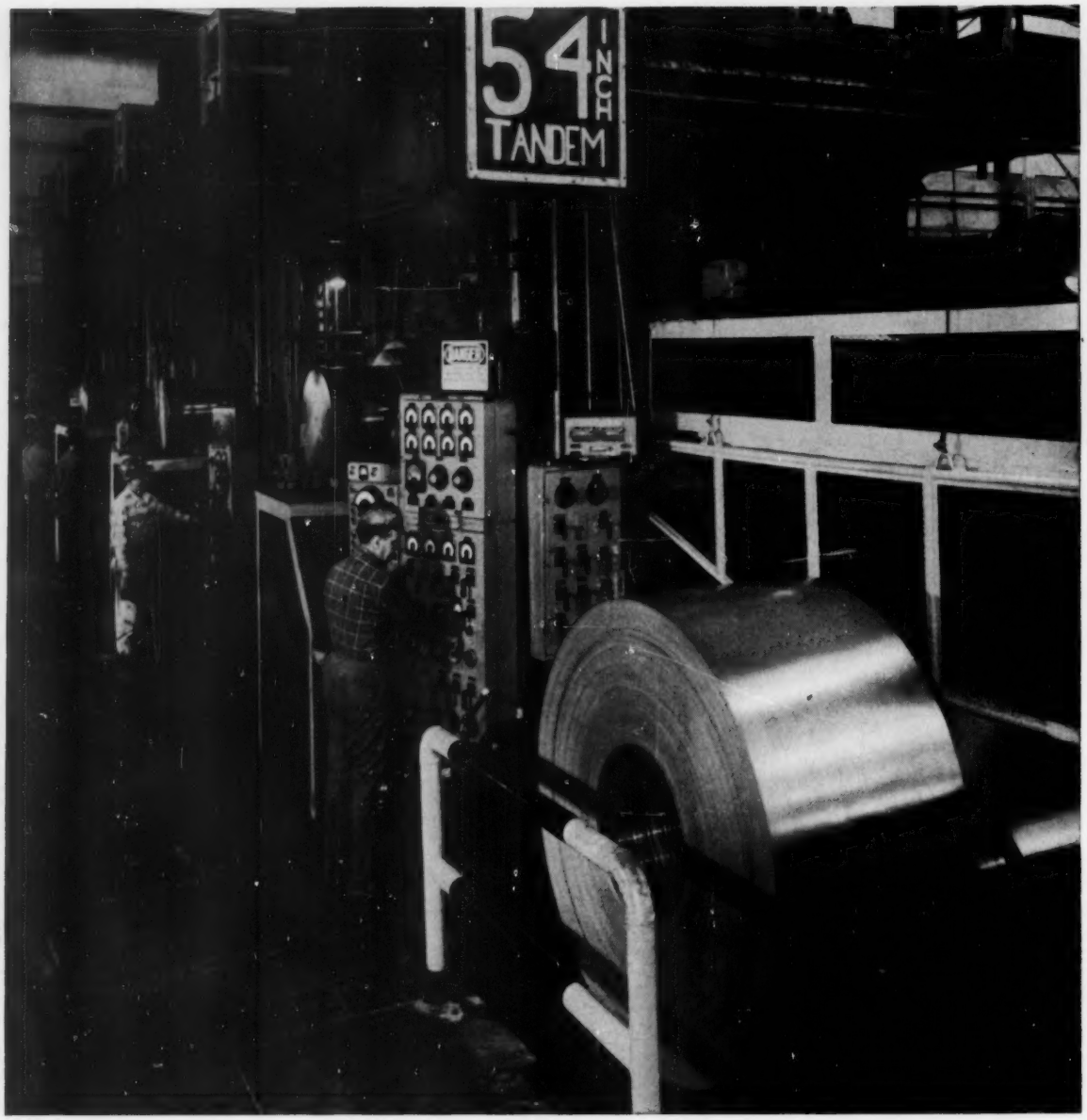
Johns-Manville has developed a range of frictions to meet almost any requirement. Each piece can be depended on to give the sort of performance expected in well-designed equipment. And experienced J-M Representatives and extensive J-M research facilities are ready to help you select the most effective and economical material. Where miniaturization is a factor . . . in wet or dry operations . . . J-M Frictions can be ordered as small, integrally molded precision parts. J-M Small Molded Parts can also be compounded for anti-friction needs such as rotary seals, bushings or bearings. Now—before you get to work on that new design—is a good time to consult your J-M Friction Specialist.

For your free copy of the J-M Industrial Friction Materials Guide, giving recommendations, design and operational data on all J-M friction types and styles, write Johns-Manville, Box 14, New York 16, N.Y. In Canada: Port Credit, Ontario. Ask for FM-35A.

JOHNS-MANVILLE

JOHNS-MANVILLE JM PRODUCTS

Circle 487 on Page 19



We baby these sheets to do a man's job

Here goes a coil of Bethlehem sheets, sinewed to stand up under rugged duty, as only steel can. To bring sheets to this superlative condition, Bethlehem pampers them like a newborn babe.

From open hearth to shipping room, their progress is checked under the watchful eyes of man and X-ray. Slabs are expertly scarfed. Reheating is controlled by the latest scientific instruments. Rolling and coiling temperatures are carefully controlled.

The finished sheet—whether hot-rolled or sent through the 10 additional steps of cold-rolling—is the result of meticulous care all along the way. You can *always* count on Bethlehem sheets to do a man's job! Put them to the test in your plant.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Distributor:
Bethlehem Steel Export Corporation

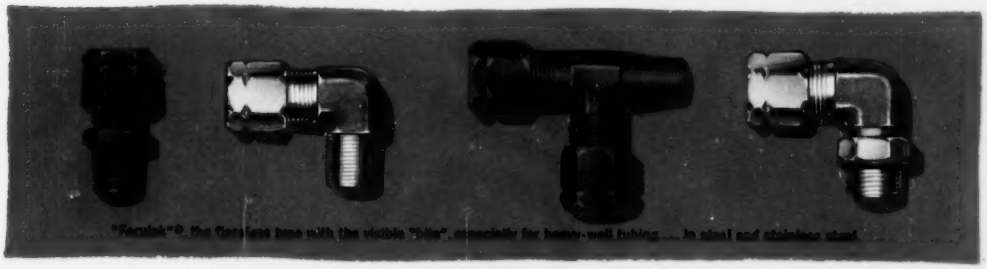
BETHLEHEM STEEL

BETHLEHEM STEEL

Circle 488 on Page 19 Circle 489 on Page 19 for Cylinders and Fittings→

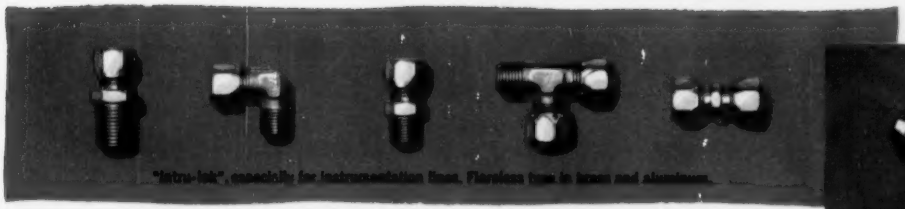
PARKER-HANNIFIN FLUID-SYSTEM COMPONENTS

"Triple-lok", the "industrial standard"... in brass, stainless steel, aluminum, and cadmium plated steel. For flared tubing.

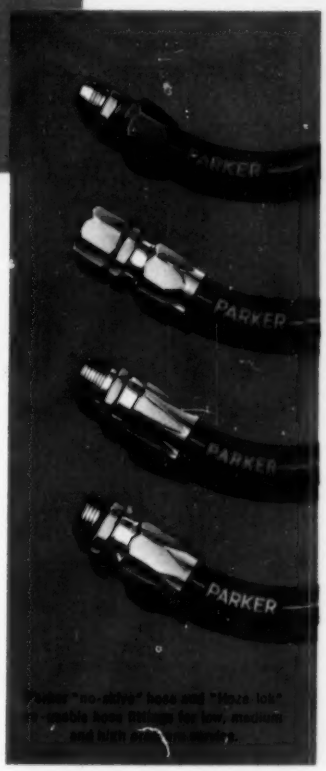


"Ferulok"®, the fine-line line with the visible "bite", especially for heavy-wall tubing ... in steel and stainless steel.

"Weld-lok" socket-type fittings, steel or stainless steel. Also "Braze-lok", in almost any metal.



"Intru-lok", especially for instrumentation lines. Flareless type in brass and aluminum.



"Hoze-lok" "no-skive" hose and "Hoze-lok" re-usable hose fittings for low, medium and high [illegible]

Only from Parker

such a wide range of fittings...so fast

If it's an industrial fitting, whether for tubing or for hose, Parker has it or can make it, in standard sizes in any metal.

Parker "Triple-lok" for flared tubing . . . Parker "Ferulok"® for heavy-wall tubing . . . Parker "Weld-lok" for high-temperature, high pressure lines. ("Braze-lok", our newest line, does not require an open torch, is for medium temperatures.) "Intru-lok", for copper, aluminum or plastic instrumentation lines, requires no flaring. Parker hose and "Hoze-lok" re-usable hose fittings require no skiving of the hose.

There's a Parker distributor near you, write us for his name . . . call him for Parker catalogs.

Parker Fittings and Hose Division
17325 Euclid Avenue • Cleveland 12, Ohio

A DIVISION OF PARKER-HANNIFIN CORPORATION

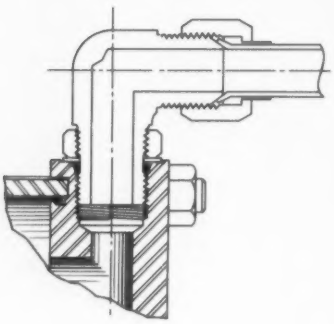
Bronze cartridge gland with "LIPSEAL"® and "WIPERSEAL" can be easily replaced without dismantling cylinder.

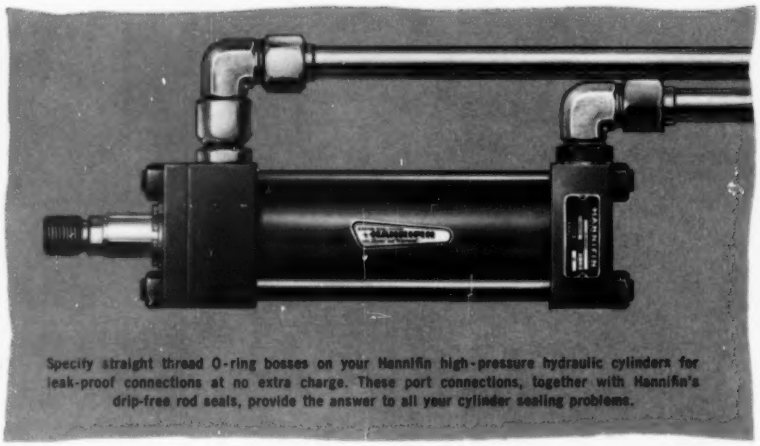
Drip-free rods, leak-proof ports...

get both with

HANNIFIN

hydraulic cylinders





Specify straight thread O-ring bosses on your Hannifin high-pressure hydraulic cylinders for leak-proof connections at no extra charge. These port connections, together with Hannifin's drip-free rod seals, provide the answer to all your cylinder sealing problems.

For absolutely leak-proof connections under all operating and installation conditions, get Hannifin hydraulic cylinders with S.A.E. straight-thread ports. There's no extra cost. And because a straight-thread fitting is tightened *after* alignment, not aligned by "backing off," sealing is positive even when the cylinder must be mounted in tight quarters.

Straight-thread ports, plus the removable-replaceable cartridge gland that seals Hannifin cylinder rods drip-free, keep machines, floor and product free of hydraulic oil.

Other Hannifin cylinder features include ground and polished rods induction-hardened to an extra-deep case, then hard-chrome plated and polished again; cylinder walls that are "Tru-Bored" straight and perfectly round *before* being honed . . . PLUS 48-hour shipment in emergencies on standard Hannifin cylinders.

Your nearest Hannifin sales office or representative is listed in the A-Z volume of Thomas' Register. Call us in when cylinders figure in your designs. Or, for cylinder literature, write:

HANNIFIN COMPANY

515 South Wolf Road • Des Plaines, Illinois

MT. VERNON DIE CASTING ENABLES FOREMOST TO UNDERSELL ELECTRIC CAN-OPENER MARKET

CASE HISTORIES FROM MT. VERNON FILES

Subject:
Foremost Appliance Corp., BROOKLYN, NEW YORK

The big reason why this quality can-opener can sell for far less than all its competitors: it was designed expressly to simplify assembly by utilizing all of die casting's unique advantages—high strength-to-weight ratio, great flexibility of shape, inherent reproducibility, high production rate, clean finish and high degree of dimensional accuracy.

The result is an intricate integral casting that contains, among other details, bearing wells for motor drive shaft and reduction gears, along with bosses to mount the heavy-duty, high-speed motor and gear train. There are no bearing alignment problems, because the casting is extremely strong...able to hold critical tolerances despite its light weight and compactness.

The casting also contains bosses for back-panel mounting, recessed cam actuator channel, switch actuator guide pins, switch mounting guide, slots and perforations for the sliding face plate, front and bottom air vents, and switch-limiting post projecting from the trim, modern face. These rigid, rugged castings are supplied trimmed and machined, with switch slot and mounting holes already punched. 12 secondary assembly operations were thus eliminated from the prototype.

Mt. Vernon's experienced four-fold service helped solve Foremost's challenge in record time...an 11th hour challenge to have their product in stores in time for Christmas selling. First...designing the many cost-saving features into the casting—second, making the extremely intricate, extremely precise dies, with nameplate inserts—third, utilizing their huge, modern die-casting facilities for lower-cost quantity runs of more perfect castings—and fourth, complete machining facilities for on-time delivery of clean castings ready for baked-enamel finishing and assembly.

Mt. Vernon's coordinated four-fold services are under one roof—in 200,000 sq. ft. of space...ready to help you produce a finer product through the unique benefits only die-casting offers. A call to your nearest Mt. Vernon representative—for information or assistance at any phase—may also help you solve the problem of how to undersell your competitors. He'll be glad to talk it over. Call him today.

MT. VERNON
DIE CASTING CORP.
STAMFORD CONNECTICUT

RESEARCH PARTICIPANT

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VALLEY FORGE, PA., Mr. A. T. Hollander, P.O. Box 115

←Circle 489 on page 19 for Cylinders and Fittings

Circle 490 on Page 19

Got a problem that calls for thread-cutting screws?

PARKER-KALON offers three new, improved thread-cutting screws for every application in every material

1 New, Improved P-K Type F*

. . . hardened thread-cutting screws developed for use in friable, granular or brittle material. The pilot, with its five tapping flutes, cuts a machine screw thread as the screw is turned in. The Type F is ideal for making fastenings to ferrous and non-ferrous castings, bronze or brass forgings, heavy gage sheet metals, structural steels, plastics and resin-impregnated plywood.

2 "Pentap"... the new, Improved P-K Type B-F*

(formerly F-Z) combining the five thread-cutting flutes of the Type F screw with the coarse-pitch, widely-spaced threads of the P-K Type B. The thread-cutting "Pentap" Type B-F distributes cutting pressure evenly, lets chips drop to the bottom of the hole, and prevents cracking of material. It is designed for making fastenings to comparatively thin sections and bosses in friable and brittle plastics.

3 P-K® Type L†

. . . is a completely new and improved thread-cutting screw developed by Parker-Kalon especially for use in Nylon. The Type L functions as a combination thread-cutting and thread-forming screw in that it cuts a small amount of the Nylon to allow the full diameter threads to form. Type L offers a particular advantage in Nylon assemblies which must be disassembled for service, because *the P-K Type L can be removed and replaced without stripping or galling.*

The five cutting flutes on the new, improved P-K Type "F" and "BF" reduce pressure development by 80 percent! The completely formed threads on these screws have sharper cutting edges, and 5 deep flutes that are of continuous depth. These features make for better clearance of the accumulated material and assure minimum stresses in driving, and avoid the possibility of stripping or galling.

FOR SEMS . . . and Neoprene or Nylon washer **STAPS®** in thread-cutting and thread-forming tapping screws, or machine screws in any kind of pre-assembled fastener-washer combination, P-K can supply them, too!

FOR SAMPLES OF P-K THREAD-CUTTING SCREWS AND SEMS, CALL YOUR LOCAL P-K "BULK-STOCKING" DISTRIBUTOR

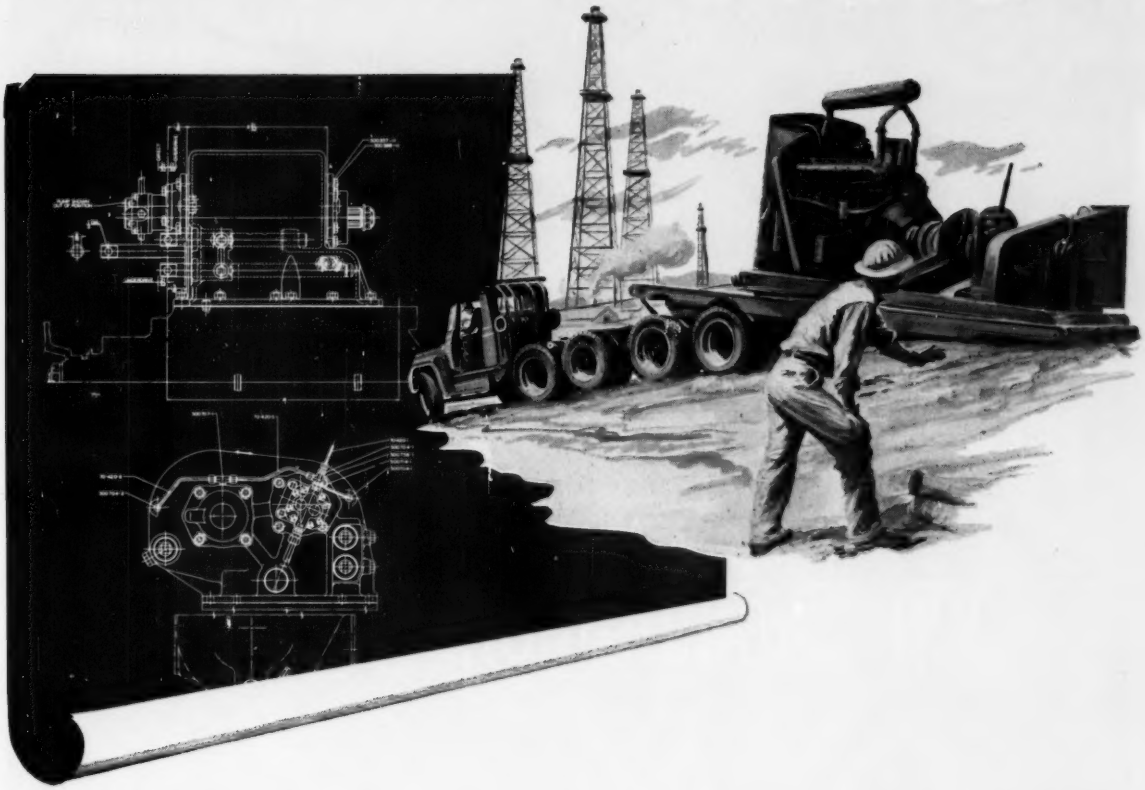
PARKER-KALON® fasteners

PARKER-KALON DIVISION, General American Transportation Corporation, Clifton, New Jersey • Offices and Warehouses in Chicago and Los Angeles

KEEP AMERICAN INDUSTRY AT WORK . . . BUY P-K . . . MADE IN U.S.A.

*Patent Pending †U. S. Patent 2,350,348

NEW SPICER PTO HAS GREATER CAPACITY FOR HEAVY DUTY WORK



● Rugged, round-the-clock service, where full engine torque is a "must", calls for a top-mounted PTO with the capacity to transmit that torque constantly and smoothly. Whether the vehicle is an oil field rig, a cement mixer truck, or a sand and gravel dump, the job can be done at highest operating efficiency with a Spicer forced-feed, top-mounted power take-off.

The Spicer top-mounted PTO—with either a Spicer 8031 or 8341 auxiliary transmission—outlasts conventional PTO's because positive lubrication is assured at all times, regardless of the operating angle of the vehicle. An oil pump provides forced-feed lubrication at slow speeds with full engine torque.

Spicer top-mounted power take-offs transmit the full torque of the engine with forward transmission in direct drive, or loads equivalent to engine torque with forward transmission in gear, to operate air compressors, heavy duty winches, large pumps and other equipment. Two speeds forward, one speed reverse.

Where definite torque rating of the Spicer PTO is desired, Dana engineers will gladly submit this information upon receipt of complete data on the installation and type of operation.

For further information write Dana Corporation, Toledo 1, Ohio.

DANA Spicer

DANA CORPORATION

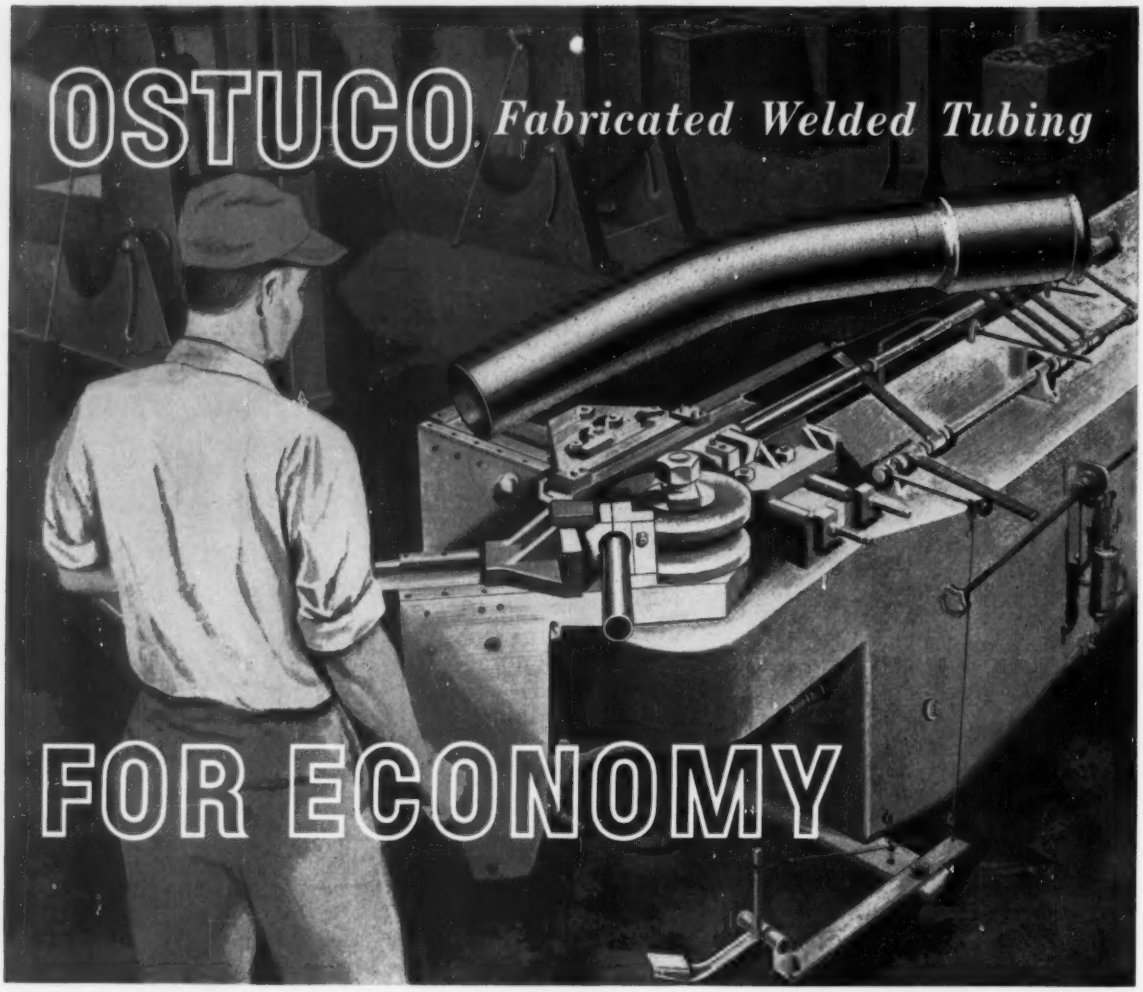
Toledo 1, Ohio

SERVING TRANSPORTATION — Transmissions • Auxiliaries Universal Joints • Clutches • Propeller Shafts • Power Take-Offs Torque Converters • Axles • Powr-Lok Differentials • Gear Boxes • Forgings • Stampings • Frames • Railway Drives

Many of these products are manufactured in Canada by Hayes Steel Products Limited, Merritton, Ontario

Circle 492 on Page 19

Vacuum Cleaner Manufacturer Specifies



Bending vacuum cleaner wand. A variety of fabricating operations also is performed on Ohio Special Quality Seamless Tubing.

"Value analysis showed it would be more economical to buy than produce fabricated welded tubing parts for our new cleaner. What's more, we could avoid additional capital investment in equipment.

"So we added Ohio Seamless to our production line. They have the equipment and facilities to meet our design requirements and to hold to our stepped-up schedules. And we don't pay shipping costs on scrap — just on finished parts . . ."

Let Ohio Seamless translate your designs into finished parts . . . conserve your capital . . . cut your production and shipping costs. Contact your Ohio Seamless representative, listed in the Yellow Pages, or the mill at *Shelby, Ohio — Birthplace of the Seamless Steel Tube Industry in America.*

AA-8847

OSTUCO TUBING

OHIO SEAMLESS TUBE DIVISION

of Copperweld Steel Company · SHELBY, OHIO

Seamless and Electric Resistance Welded Steel Tubing • Fabricating and Forging

SALES OFFICES: Birmingham, Charlotte, Chicago (Oak Park), Cleveland, Dayton, Denver, Detroit (Huntington Woods), Houston, Los Angeles (Lynwood), Miami, Moline, New Orleans (Chalmette), New York, North Kansas City, Philadelphia (Wynnewood), Pittsburgh, Rochester, St. Louis, St. Paul, Salt Lake City, Seattle, Tulsa, Wichita CANADA: Railway & Power Engr. Corp., Ltd. EXPORT: Copperweld Steel International Company, 225 Broadway, New York 7, New York

now the Bruning Man brings you the hardest-working, lowest-cost whiteprinter for its size anywhere!

Designed by Palma-Knapp Associates

BRUNING Diazo Copying at its Best **Copyflex**®

A medium-volume machine with big-volume features at a low-volume machine price! That's Bruning's new Copyflex Model 430 diazo-printer. It gives you such important features as big 42-inch printing width, 30 f.p.m. mechanical speed, simple *one*-knob control, automatically synchronized exposure and development, positive pressure-roller development of all types of materials at any speed at a *single* pass, and a split-print stacking tray. Add the famous Copyflex years-ahead construction, odor-free, vent-free operation, and you have the greatest whiteprinter value today. The coupon brings you proof.

Charles Bruning Company, Inc. Dept. 12-X
1800 Central Road, Mt. Prospect, Illinois
Offices in Principal U.S. Cities
In Canada: 103 Church St., Toronto 1, Ontario

Please send me information on your new low-cost Model 430.

Name_____ Title_____

Company_____

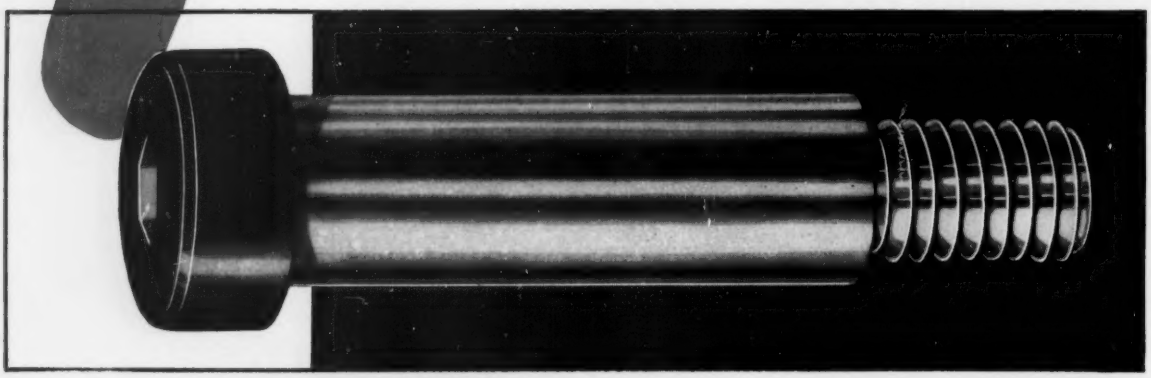
Address_____

City_____ County_____ State_____

The Bruning Man is your expert on diazo reproduction. He's backed by a company with over sixty years' experience.

Circle 494 on Page 19

Problem: *"Fasteners used to secure the stripper plate in this combination punch and die assembly must have close tolerances. Concentricity between head, shoulder and thread is an absolute must. High tensile strength is important. Head of fastener should be thin as possible to save space . . ."*



Solution: *HOLO-KROME SHOULDER SCREWS. Made of special analysis alloy steel. Hex sockets formed by the new H-K methods permit a thin head, still maintain high strength. Heat-treat warpage can now be completely removed. Both the screw shoulder and body are precision ground for exact concentricity before the body is threaded. Threads are Unified Class 3A Fit.*

For the finest in Hex Socket Screws . . . for unmatched Same-Day Service, the name to remember is Holo-Krome.

HOLO-KROME
SOCKET SCREWS

THE HOLO-KROME SCREW CORPORATION • HARTFORD 10, CONN.

SOLD ONLY THROUGH AUTHORIZED HOLO-KROME DISTRIBUTORS

J. F. HARPER, OF HARPER
BUFFING MACHINE COMPANY, SAYS . . .

"General Electric Motor *Econo-matching** Saved Me Over $1300 Per Machine!"

***GENERAL ELECTRIC ECONO-MATCHING** is the quick and accurate matching of Tri-Clad '55' a-c motors to machines by skilled G-E engineers.

ECONO-MATCHING recently helped increase equipment efficiency and reduce unit costs at Harper Buffing Machine Company, East Hampton, Connecticut.

After selecting a drive to power his new "Harperizer†" free-grain buffing machine, J. F. Harper (above center) called his G-E Distributor, who in turn arranged for a team of General Electric Econo-matching engineers to study its drive requirements —at no cost to Mr. Harper!

"G-E ENGINEERS STUDIED OUR APPLICATION," said Mr. Harper, "and advised that we could get maximum efficiency and economy by replacing the drive we had selected with a Tri-Clad '55' 50-hp open drip-proof motor. We did, and realized an immediate savings of over $1300 per unit!"

MORE THAN THREE BILLION integral-hp a-c motor types are available to the G-E engineers who can select the drive to meet your needs. Let them help you get the most from your equipment investment!

†Trademark of Harper Buffing Machine Co.

GENERAL ELECTRIC

‡ Registered Trademark of General Electric Co.

RETURN THIS COUPON . . .
for more Econo-matching details, or call your nearby General Electric Apparatus Sales Office for complete information on how G.E. can ECONO-MATCH a motor to meet your specific requirements.

Circle 496 on Page 19

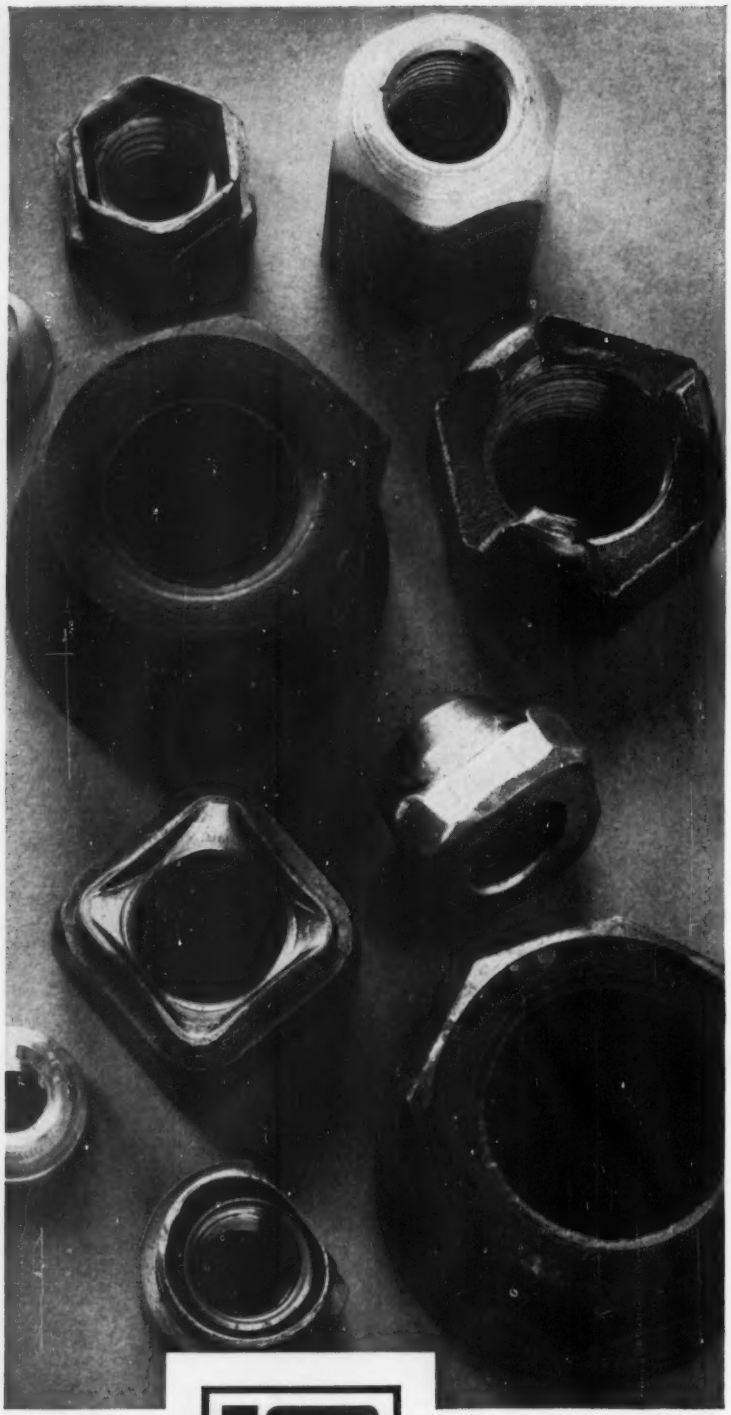
Section F891-22A
General Electric Company
Schenectady, New York

Please furnish more information on how you can ECONO-MATCH a motor for my application, which is_____

NAME_____ TITLE_____

COMPANY_____

CITY, STATE_____



A nut is a nut... or is it?

At L & S, we produce hundreds of special nuts to customer specifications... a few of which are shown here. Many times, our engineers develop the design—to meet a customer's specific fastening problem. Need a special-purpose nut or other fastener that doesn't exist? We have the know-how *and* the equipment to design it, produce it, economically!... Send us your prints or problems.

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DESIGN
December 10, 1959

Who? Me?

THIS fellow Raudsepp (Page 24) has got a point. He really nails down the "typical engineer."

Now, you take George, over in Group 13. He's a typical engineer if I ever saw one.

He doesn't understand people at all —always gets them mad at him.

Me? Well, I try to keep a discussion objective, but some of those jokers in Production are awfully touchy.

And he's a real "cookbook" engineer. No imagination. Not really creative at all.

Not that I like wild ideas. There's no sense in going off half-cocked on an untried notion.

George is a real fusspot, too. Takes forever to do a job.

Of course, I take time, too. But it's only because I like to be accurate. You've got to be sure a job's right.

You should see his reports. They sound like doubletalk. He may be a good engineer, but he sure can't write.

Oh, I don't write many reports. Never did like writing, and besides, you can get things done faster by talking to people.

Talk about the original Great Stone Face. That's George! Oh, he's friendly enough. But you never know how he really feels about things.

Maybe he's right, though. Take the boys in Sales, with all that glad-hand approach. Mighty hard to take. Keep it casual, I always say.

And George worries about getting ahead. Always got to be right—always pushing.

Why worry! Take me, for instance. I've got a nice job, and I'm happy here . . . if they keep the raises coming.

Like I say, George is a real typical engineer.

Me? Of course not!

Robert L. Stedfeld

ASSOCIATE MANAGING EDITOR

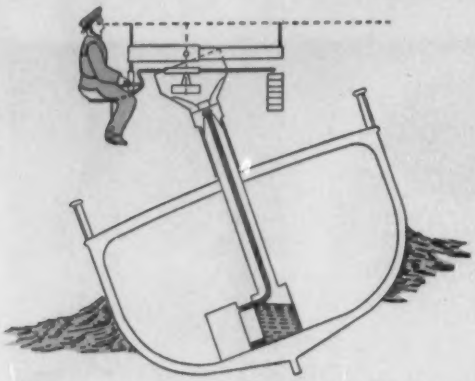


Fig. 1—Object of Tower's position servo was to hold gun platforms horizontal. Water pumped at 100 psi provides power for a gyro and a hydraulic servo housed just beneath the platform.

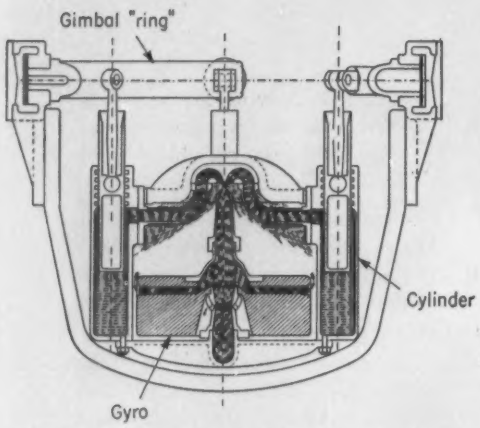


Fig. 2—Massive gyro wheel is driven by tangential jets at about 1000 rpm. Water is bled through the axial jet to a cluster of four holes leading to four cylinders. Displacement of the holes from the jet initiates corrective action.

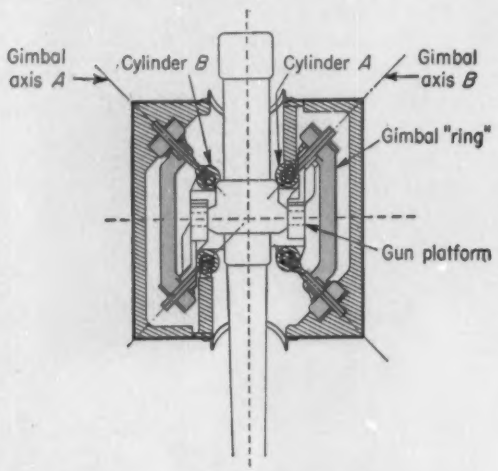


Fig. 3—The cylinders act to level the gun platform through gimbal arms (in color). Cylinder *A* and its opposite rotate the platform about gimbal axis *A*, and the *B* cylinders rotate the platform about axis *B*.

vintage 18

a Position

A GUN-STABILIZING platform proposed by Tower 70 years ago, Fig. 1, combined two seemingly original inventions: A self-energized gyro and a pressure-recovery jet servo.

The large gyro wheel, Fig. 2, rotates on a hollow-ball swivel, through which water is pumped at 100 psi. Some of the water feeds a pair of tangential jets on the periphery of the wheel. The wheel rotates on the Hero's wheel principle at about 1000 rpm. It becomes self-erecting and, due to the location of the pivot center, produces the true vertical.

A bleed of water is taken up the central gyro spindle and issues from another jet. Around this nozzle is a cluster of four holes, each communicating by a pipe to a cylinder coupled to the gun platform, Fig. 3. If the jet covers the four holes symmetrically, the pressure conversion in each pipe is equal, and the cylinders are subjected to equal pressure. If the platform moves sideways with respect to the jet, the pressure build-up in one or two cylinders increases in a manner tending to restore the four pipes once more to the center of the jet. The platform thus follows by direct servo action the vertical-seeking gyro wheel, and remains truly horizontally stabilized.

This unique mechanism was developed well before its time. Tower described the practical trials, making clear that the degree of stabilization was

89 Servo

H. G. CONWAY
Chief Engineer
Short Brothers and Harland Ltd.
Belfast, Ireland

This hidden treasure has been unearthed from the 1889 *Transactions of the Institution of Naval Architects*. There, Beauchamp Tower, well known along with Reynolds and Froude for work on fluid friction, described his "Apparatus for Providing a Steady Platform for Guns at Sea."

He did more than talk about it—he built one and tried it with a small gun on his own steam yacht.

Here—for your interest and amazement — is how it worked and what happened to it.

excellent. "The stiffness of the platform," he said, "or its power of resisting disturbing forces, can be regulated by varying the proportion between the areas of the cylinders and the length of the axial jet. There is, however, a limit to the amount of stiffness which can be given, owing to a tendency to oscillate showing itself if the platform is too stiff, but I have been able to make that of the present machine so stable that 300 pounds on a lever one foot long causes an inclination of only one degree. The amount of error caused by the friction of the bearings and other mechanism is only about three-quarters of a minute of arc."

Discussion on the paper at the time brought forth some interesting and favorable comments from other distinguished engineers who had seen and tried the device. Several commented on the elimination of sea sickness.

The most interesting (and adverse) comment was from Admiral Sir John Hay who was so ill-advised as to say: "I do not conceive that [the invention] would be of any special value to us. It seems to me that the training of a Naval gunner is this: To do that which we all may understand by saying that he has to shoot flying. You have to teach the captain of your gun to fire his gun, making allowance for the change in the direction of the object at the time the shot would reach it. You have also to teach him to recollect that after he has pulled the trigger, and the charge is ignited, there is a certain arc which the muzzle of the gun is passing through while the shot is traversing the bore. All these various considerations have to be present in his mind, and when he is an experienced gunner he makes allowances for all these various circumstances, and his shot will eventually attain the moving object from the moving gun which he has discharged. I do not believe that eliminating one of the difficulties would increase his attention to the other difficulties."

In reply Tower exercised considerable restraint: "I can only say that I am quite willing to back myself against the best shot he can bring forward, and see who will make the best shooting: His man, with all the admirable skill he speaks of—and certainly it is most admirable in consequence of the great trouble which must have been taken to acquire it—or myself, on the machine. I can quite understand his feeling of sorrow that so much skill should be rendered unnecessary, but at the same time we must bear in mind that some day there will be a shooting match in which the stake will be an Empire, and we must not allow a sentimental affection for skill, no matter how admirable, to prevent our providing the best means to enable the men on our side to hit the target most often."

malleable IRON— Hot and Cold

Fig. 1 — Malleable iron eyebolt plugs received repeated blows of 60 ft-lb from room temperature to −40 F. Holes deformed from 1¼ in. diam to 1 1/16 in. without fracture.

STANDARD malleable iron is well suited to applications in a temperature range from −60 to 1200 F. Low-temperature investigations have been concerned primarily with impact resistance and notch-sensitivity. High-temperature studies have focused principally on tensile strength, yield point, elongation, stress-rupture, and creep.

Low-Temperature Effects

Standard malleable iron appeared fairly insensitive to temperature effects down to −80 F in studies employing Charpy tests of notch bars, wedge tests, and tests of unnotched specimens. Tests of the impact resistance of standard malleable-iron eyebolt lifting plugs, Fig. 1, were made by repeated blows of 70 ft-lb in the standard wedge test machine from room temperature to −40 F. In this range, the original 1¼-in. diameter eye of the plug was deformed to 1 1/16 in. without fracture.

Simulated service tests were conducted on sample castings of standard malleable iron which had an

Table 1—Impact Strength at Low Temperatures*

At 10 F (ft-lb)	At −40 F (ft-lb)	At −60 F (ft-lb)
92 ft-lb	90 ft-lb	104 ft-lb
78	72	72
110	106	96

*Modified Izod tests on malleable iron bars 0.505 in. diam, 2.85 in. long.

For years, malleable iron castings have been used at "room temperatures" where high strength and resistance to shock loads are required. Present trends, however, require products to operate over much wider temperature ranges. This article — condensed from a new handbook, *Malleable Iron Castings*, available in early 1960 from Malleable Founders Society—shows how standard malleable irons meet these new demands from −60 to 1200 F.

average section thickness of ¼ in. Held at −70 F, the castings were positioned over an inverted V-block and were struck by a small drop hammer, the blow being 60 ft-lb. After twelve blows, the mouth of the casting had enlarged 50 per cent and had bottomed on the V-block, but the casting had not fractured. In a different series of impact-strength studies the results in Table 1 were obtained.

Behavior of standard malleable iron under impact at low temperature in heavy as well as light sections was studied at the Naval Research Laboratory. The drop-weight test was used to find the nil-ductility transition (NDT) temperature—the critical point at which a ferrous material loses its ability to deform in the presence of a stress-raiser such as a sharp crack or a hard welded bead. Explosion tests of plates established relative resistance to the starting and propagation of brittle fractures at temperatures above the NDT temperature. Charpy V-notch transition curves were related to the behavior of the specimens in the other tests.

Findings were: 1. NDT temperature increases proportionately with phosphorus content. Lowering phosphorus content below 0.01 per cent lowered NDT values to −150 F. 2. Notch ductility is insensitive to section size. 3. NDT temperature is of the order of −50 F in section sizes up to at least 3 in. thick. 4. Properly made malleable irons are inherently notch ductile and suitable for low-temperature applications.

▶ High-Temperature Effects

With rising temperatures, the tensile strength and yield point of construction materials, in general, decrease. At temperatures up to 1200 F, malleable iron does not undergo "growth," or permanent increase in volume, except under repeated heating. Heating standard malleable above approximately 1350 F alters both its structure and its properties.

To determine tensile properties, standard malleable irons were held for short times at temperatures in the range from room temperature to 1200 F. Testing speeds were 0.02 in. per minute to the yield

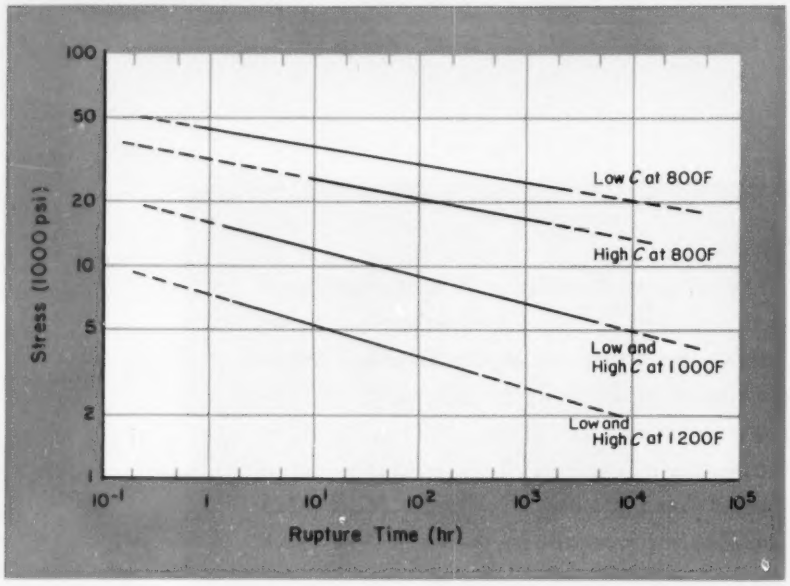


Fig. 2—Stress versus rupture time, at high temperature, for representative malleable irons having high and low carbon content.

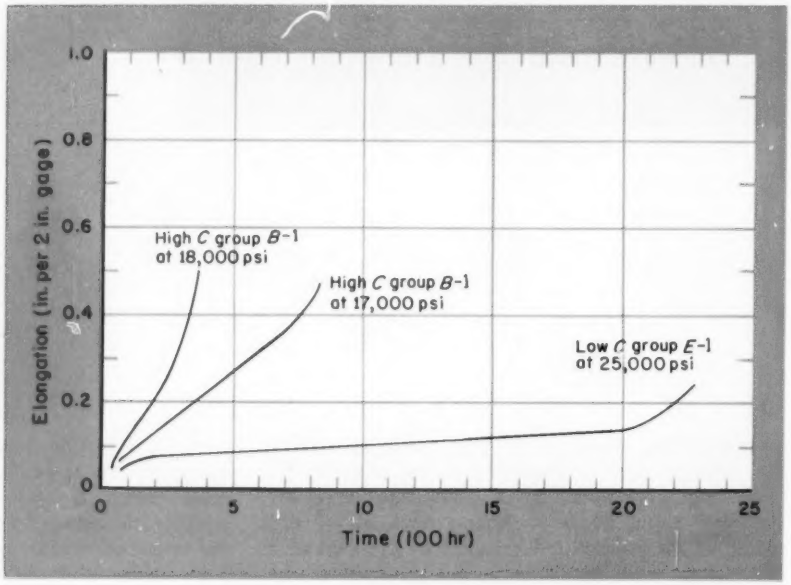


Fig. 3—Time versus elongation for two groups of malleable iron at constant temperature of 800 F and at constant loads indicated.

point and 0.2 in. per minute to the tensile strength. Results are listed in Table 2. Irons tested had the same characteristic curves for tensile properties throughout the temperature range. Tensile strength dropped about 7 per cent when the temperature was raised from room temperature to 212 F, then increases to nearly its original value when temperature was raised to 600 F. These changes are not accompanied, however, by a corresponding inverse relationship for ductility. Elongation drops continuously from room temperature to about 500 F. Above 600 F, ductility increases at a rapid rate, but tensile strength continues to decline at its previous rate until at 1200 F it is only about 25 per cent of the room temperature.

A general high level of performance for standard malleable iron held at high temperatures for long periods of time is indicated by the results of a study of stress-rupture and elongation. Chemical analyses of the specimens are shown in Table 3. Tests were conducted at 800, 1000, and 1200 F on standard 0.505-in. diameter threaded bars with 2-in. gage length.

Stress-rupture results are plotted in Fig. 2. Per-

Table 2—Properties at High Temperatures§

Temp. (F)	Tensile Strength Avg (psi)	Tensile Strength Change* (%)	Yield Point Avg (psi)	Yield Point Change* (%)	Elongation Avg (% in 2 in.)	Elongation Change* (%)
75	54,200	0	34,850	0	23.5	0
212	51,200	— 6.5	32,850	— 6.5	21.1	— 10.0
400	52,350	— 3.5	32,900	— 6.5	14.3	— 38.0
600	53,700	— 1.5	30,550	—12.0	14.1	— 40.0
800	46,500	—15.0	27,650	—20.0	21.8	— 8.0
1000	27,750	—52.0	17,400	—50.0	48.5	+105.0
1200	12,550	—77.0	7,700	—78.0	55.5	+140.0

*From room temperature.

Table 3—Representative Malleable Irons§ (Compositions in per cent)

Material	C	Si	Mn	S	P	Cr
Low Carbon						
Group A-1	2.26	1.09	0.29	0.074	0.148	....
E-1	2.16	1.17	0.38	0.095	0.137	0.017
G-1	2.29	1.01	0.38	0.086	0.11	....
High Carbon						
Group B-1	2.50	1.32	0.43	0.159	0.024	0.029

formance equal or superior to that of other ferritic materials is indicated, particularly at 800 F. Strength at 1000 F is adequate for many applications. Strength is retained even at 1200 F. These properties make malleable iron useful in special applications such as parts for ovens, driers, some types of furnaces, and many kinds of high-temperature fittings.

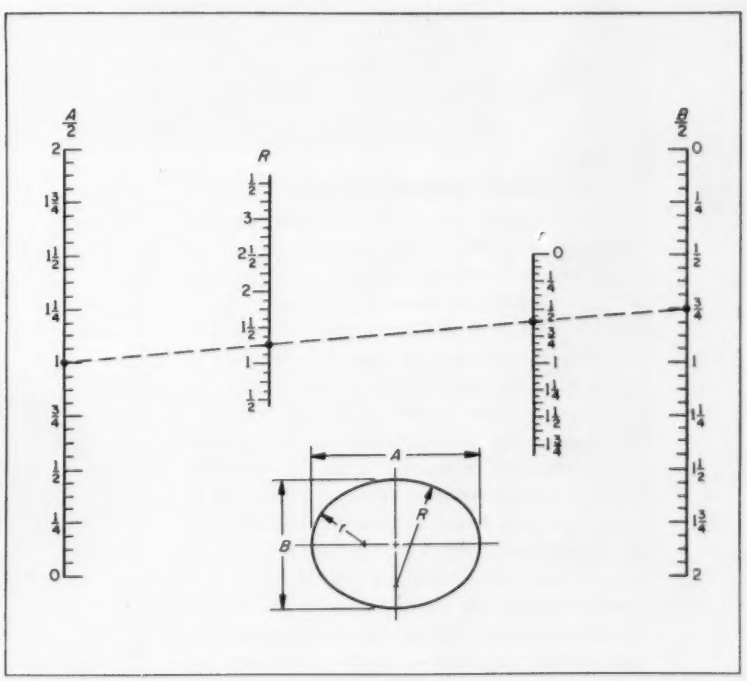
Typical time-elongation curves for two groups of standard malleable iron are shown in Fig. 3. The curves exhibit the usual three stages of creep. Also, they emphasize the normally ductile behavior of malleable iron at all times and temperatures investigated. No significant change in either elongation or reduction of area with time was noted in this study. Values obtained for the minimum creep rate — the linear or second-stage portion — varied from 0.0017 per cent per hour, for long rupture times, to 4 per cent per hour at the highest stress levels and shortest times. Actually, creep measurements are the sum of elongation due to creep and the elongation which might result from growth of the specimen such as might be caused by oxidation. However, growth, as indicated by microstructural examination and measurements on test specimens, is not significant.

§L. C. Marshall and G. F. Sommer—"Stress-Rupture Properties of Malleable Iron at Elevated Temperatures," *Proceedings*, American Society for Testing Materials, Vol. 58, 1958.

Tips and Techniques

Construction of Ellipses

Example: To find R and r for an ellipse 2 x 1.5, connect 1 on A/2 scale with 0.75 on B/2 scale. Intersections $R = 1.25$ and $r = 0.625$ are required radii.—F. MURRAY, *Chicago, Ill.*



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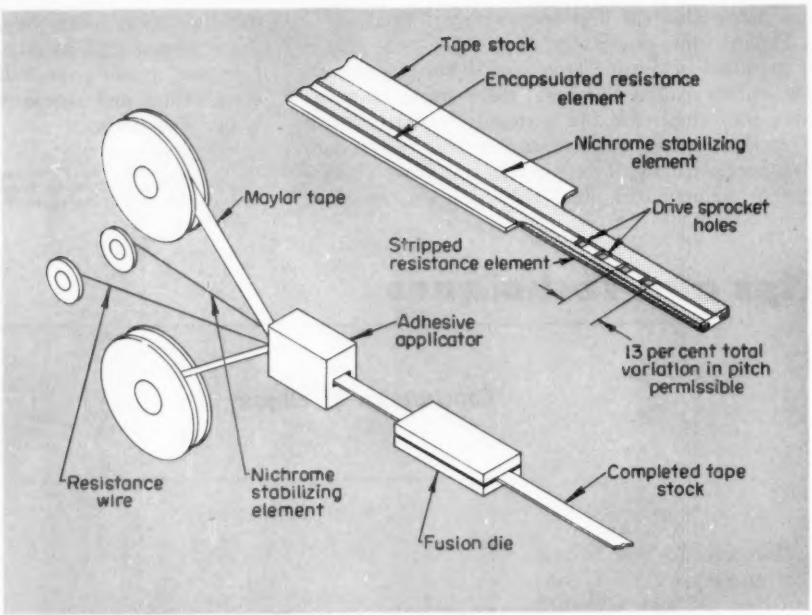
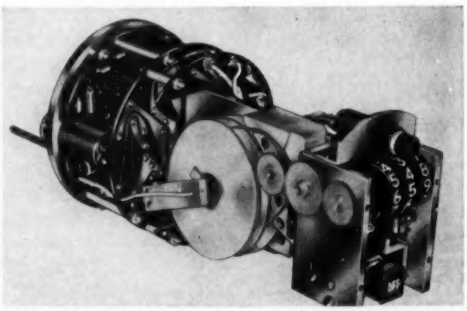
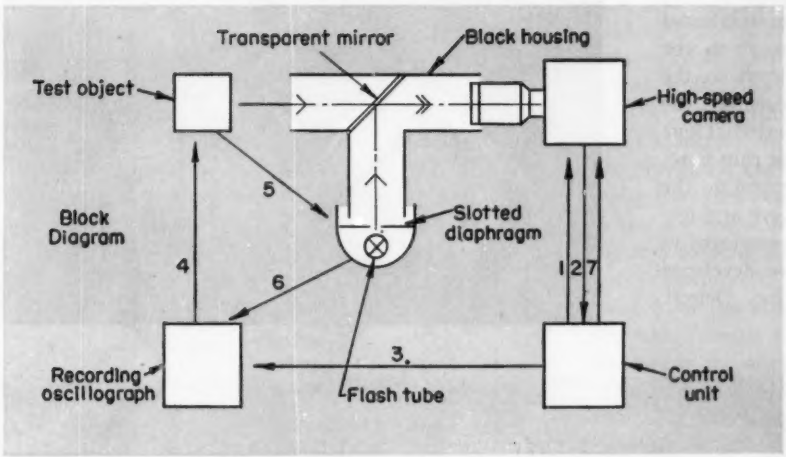
scanning the field for *ideas*

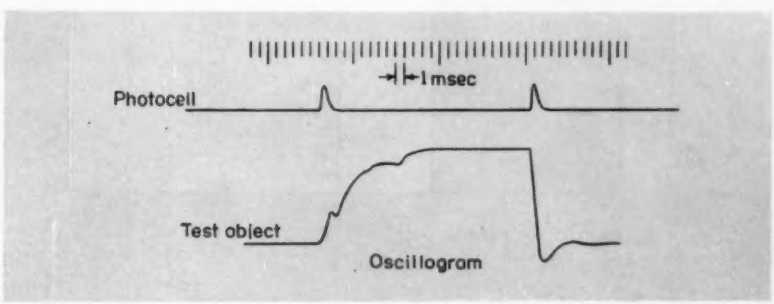


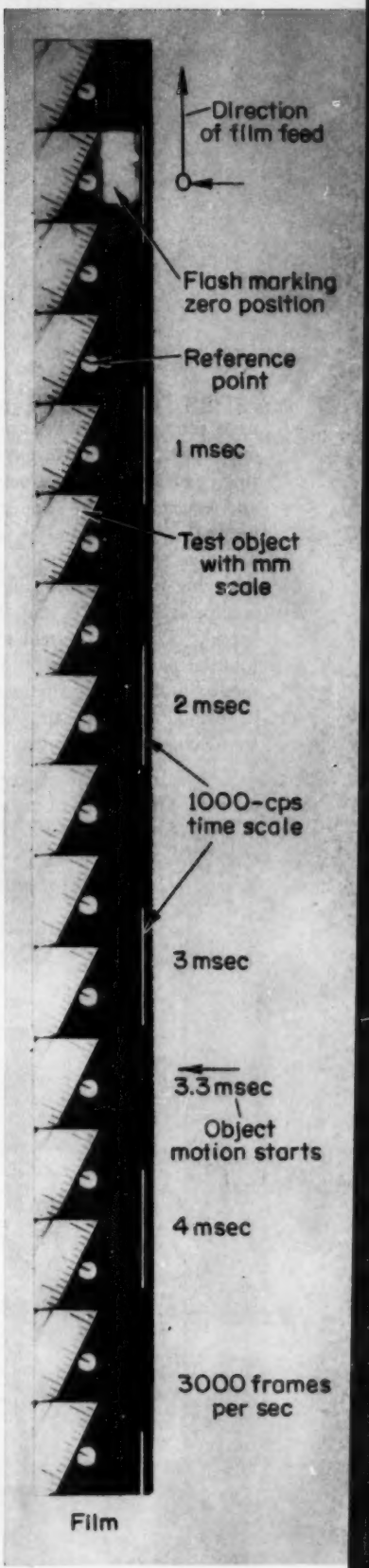
"Movie film" potentiometer linearizes nonlinear signals for analog to digital conversion of data. A solid-wire resistance element is embedded in the edge of a laminated Mylar tape so that the edge of the wire is exposed. A nichrome stabilizing element is also embedded in the opposite edge of the tape, and the tape is mounted on two spools. During a calibration operation, the tape is perforated with sprocket holes according to a predetermined program. The calibration procedure varies the center to center distance between adjacent holes. Hole spacing, which has a nonlinear relationship to the resistance of the wire, permits the tape to lag or lead the nominal peripheral travel of a tapered tooth driving sprocket to produce a linearized output. With this arrangement, inputs which vary from a linear relationship by as much as 13 per cent can be linearized. Digital readout is accomplished through a counter mechanism geared to the sprocket wheel drive shaft. Tape potentiometer principle employed in a temperature indicator developed by B and H Instrument Co., Fort Worth, Texas.



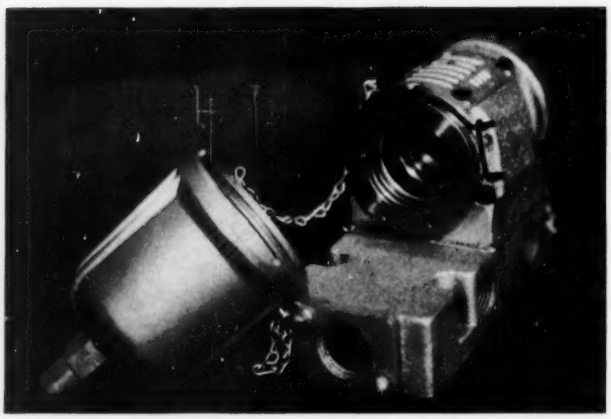


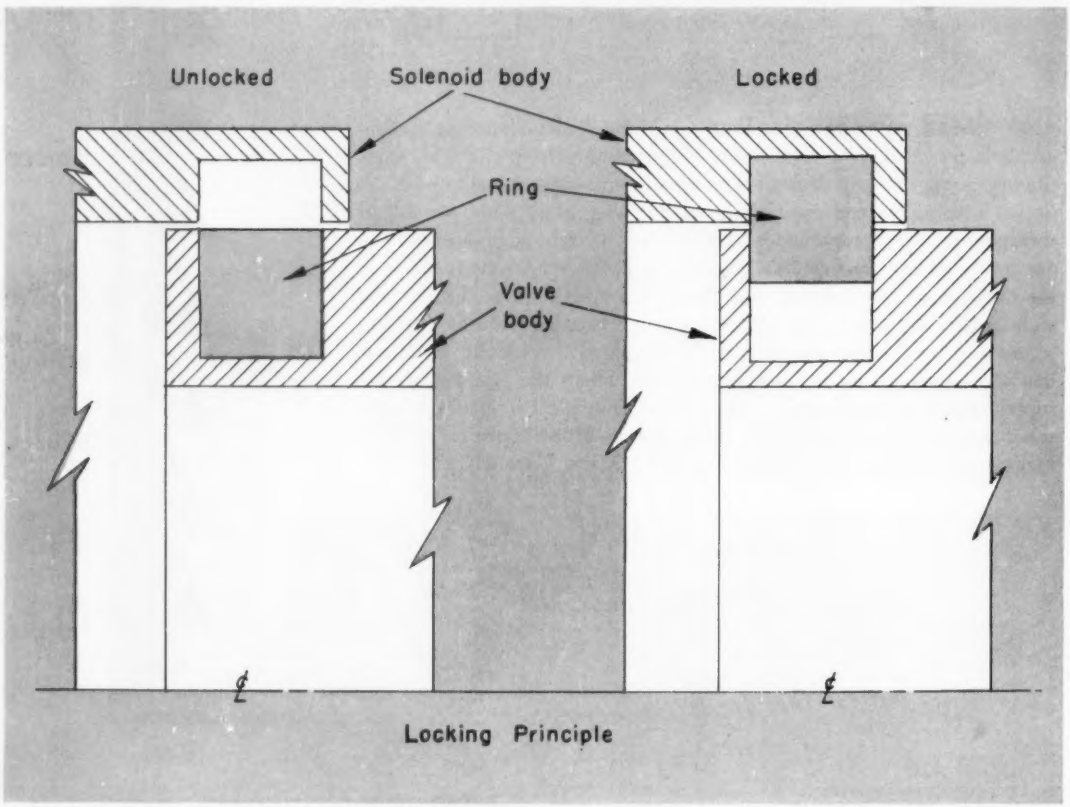
High-speed synchronization of camera and recording oscillograph is provided by a flash tube. Light flashes from the tube mark the beginning and end of test object motion on film and oscillogram. A slotted diaphragm and optically ground 45-deg glass pane, serving as transparent mirror, superimpose flash on left or right edge of object image produced on film, while a photocell supplies synchronous mark on the oscillogram. A conventional glow lamp is used to produce a time scale on the film edge. By aligning the synchronizing marks, the film record and oscillogram can be directly compared. With this technique irradication of the oscillogram is prevented when the two records are superimposed on each other. Flash tube principle employed in high-speed motion-picture equipment developed by Hoist Herbrich of Telefonbau and Normalzeit GmbH, Frankfurt/Main, Germany.



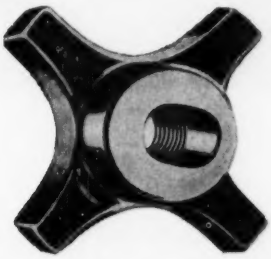


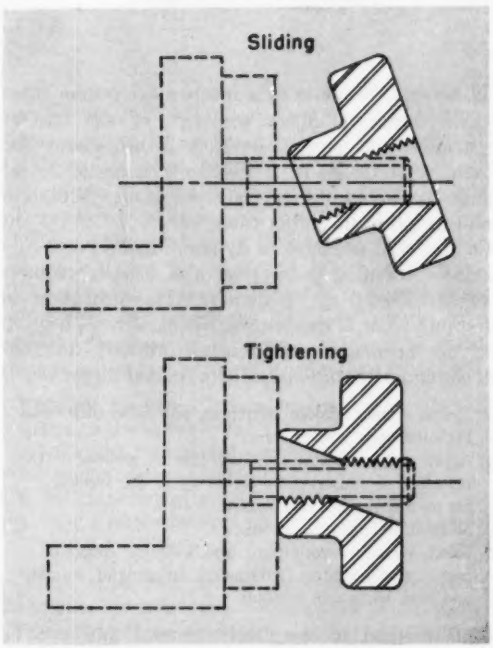
Spring ring locking of cylindrical parts simplifies assembly and disassembly operations. In a valve assembly, a wire ring engages matching grooves in internal and external parts. The groove in the internal part is equal in depth to the diameter of the wire. For assembly, the wire ring is compressed, the external part is slipped into place, and the ring is released. The ring is held captive on the internal part by a hook and eye arrangement. Spring ring principle employed in a solenoid-operated air valve developed by Mechanical Air Controls Inc., Detroit.



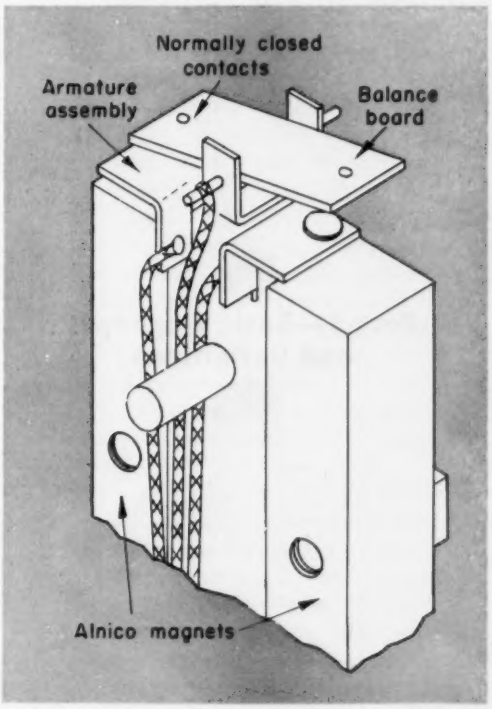


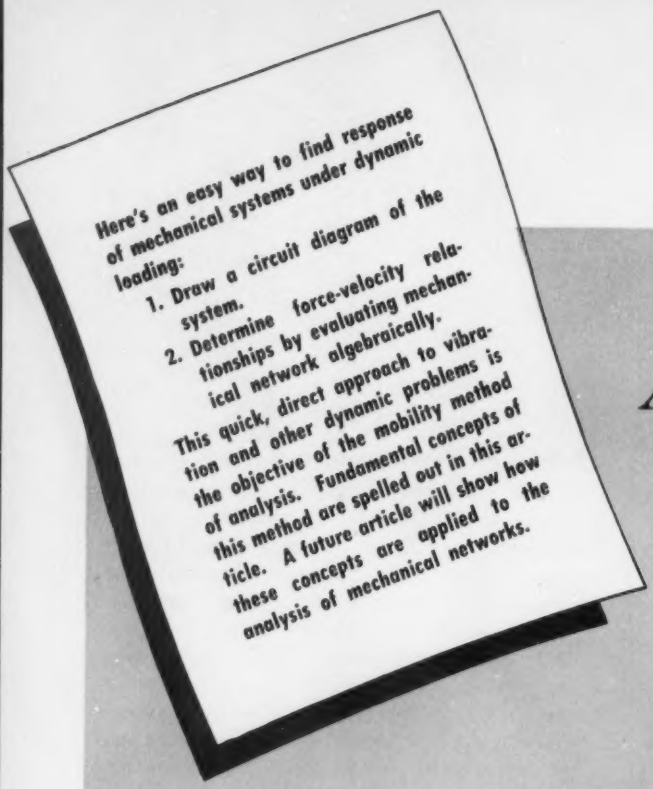
Slip-grip threads permit nut to be slipped quickly into place and then tightened for fastening. A plain bore, at an angle to the threaded bore, interrupts the threads in the nut. For fast movement, the nut is tilted so that the smooth bore surface slides over the stud. The nut is then tightened by tilting it so that the axis of the threaded hole is in line with the stud axis, engaging the threads in the nut with the stud threads. Thread principle employed in a quick-acting knob reported by Northwestern Tools Inc., Dayton, Ohio.





Balance-board armature senses the presence of a ferrous material to control operation of a proximity switch. Two magnets are assembled with like poles at the same end. An armature carrying a set of two silver contacts is positioned within the field of the two magnets in such a manner that the armature is held normally closed by one magnet. The opposite magnet provides a contrabiasing force which is normally not quite capable of moving the armature. When a piece of ferrous material is moved into the area adjacent to the normally closed contacts, flux lines from the holding magnet are shunted away from the armature. The biasing force of the other magnet then becomes the larger force and causes the armature to snap to its other position. Magnet control principle employed in a proximity switch developed by General Equipment and Mfg. Co., Louisville, Ky.




Here's an easy way to find response of mechanical systems under dynamic loading:
1. Draw a circuit diagram of the system.
2. Determine force-velocity relationships by evaluating mechanical network algebraically.
This quick, direct approach to vibration and other dynamic problems is the objective of the mobility method of analysis. Fundamental concepts of this method are spelled out in this article. A future article will show how these concepts are applied to the analysis of mechanical networks.

A practical guide to

The Mobility

. . . a powerful tool for analyzing the dynamics of mechanical systems

Part 1—Basic Concepts and Definitions

IN general, response of a mechanical system takes two forms: 1. Static response, or the various stresses and strains developed throughout the system by static loads. 2. Dynamic response, or response to oscillating or transient loads. Vibration problems fall in this latter category.

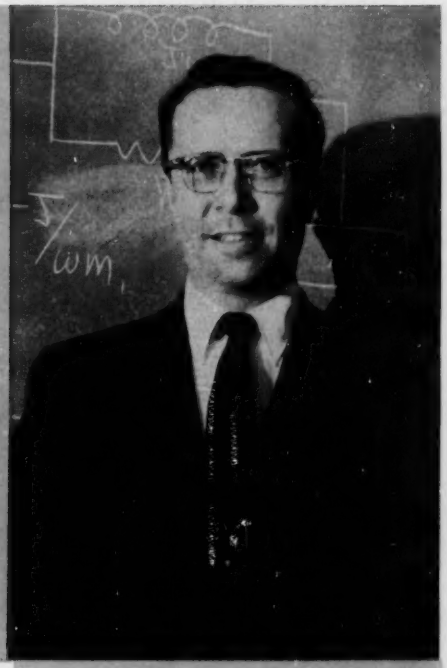
Of the two, response to dynamic load is certainly the most complex to analyze, and usually requires a higher degree of mathematical sophistication to determine what is happening. Classically, such problems are normally tackled using ordinary differential equations. Solution requires several steps:

1. Define system, choose references, and label unknowns.
2. Establish sign convention.
3. Apply either Newton's second law of motion or the principle of conservation of energy to the system.
4. Set up differential equations of motion.
5. Solve differential equations.
6. Select boundary conditions and evaluate constants.
7. Insert actual system parameters in general solution and find particular solution.

This method is completely general and can be

Method

RICHARD P. THORN
Supervisor, Electronics Group
Product Engineering Dept.
Lord Manufacturing Co.
Erie, Pa.



applied to any system as long as the differential equations can be solved. However, even with skillful handling, time required for a solution is often prohibitive, perhaps, to the point where the analysis may be abandoned.

These shortcomings of traditional methods have led to a search for new and better ways of handling dynamic problems. One of the most promising techniques developed in recent years is the mobility method of analysis. With this method, steps required in a problem solution are:

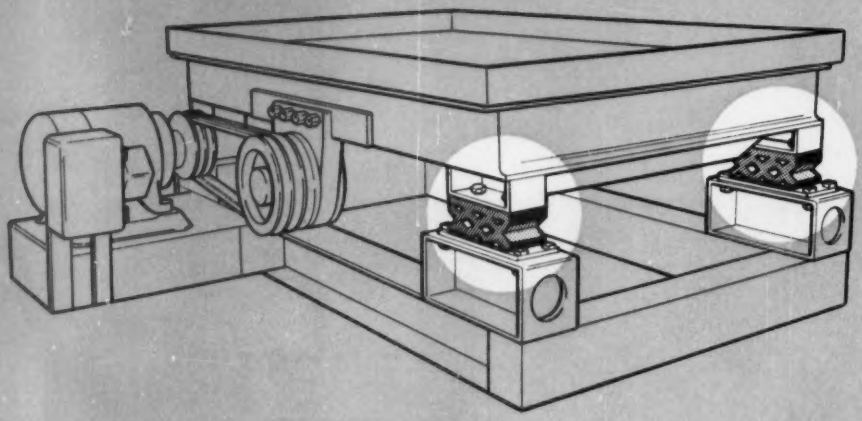
1. Define the system, choose references, and label unknowns.
2. Draw circuit diagram of system.
3. Establish sign conventions.
4. Set up network equations.
5. Solve algebraic network equations and find particular solutions directly.

Thus, with this method, dynamic response of a mechanical system can be analyzed with straightforward algebraic expressions rather than differen-

About the author . . .

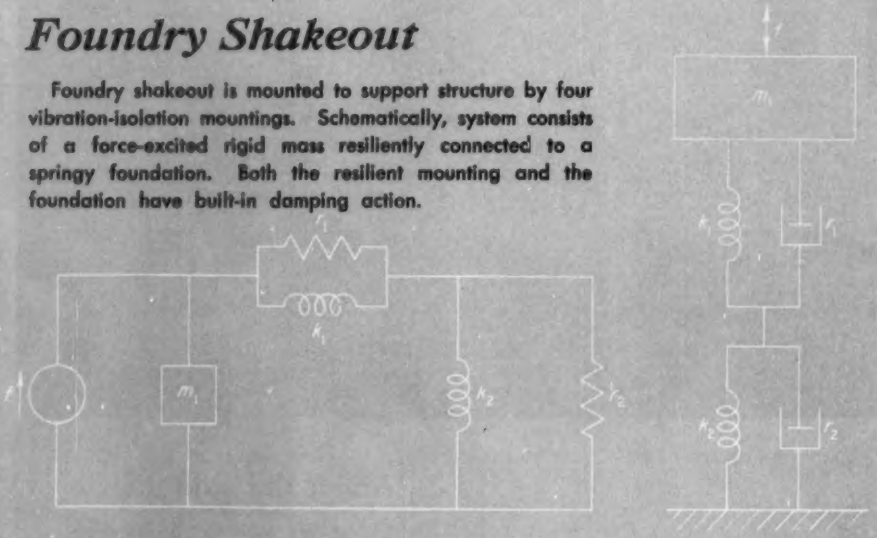
Called "Mr. Mobility" by his associates, Dick Thorn is a well-qualified authority on mobility techniques. At Lord Mfg. Co., where his work includes analysis and design of vibration control systems he has had first-hand experience in applying these techniques. Under his direction, the mobility method has been used to advantage in the design and development of mounting systems to safeguard electronic equipment against widely varying conditions of dynamic loading. The mounting system for the Atlas missile electronic packages is one of the direct results of these efforts.

An electrical engineer by schooling, he holds a bachelor's degree from Union College and a master's degree from the Carnegie Institute of Technology. He has been with Lord since 1955. In addition to his regular work activities, he teaches in-company courses in advanced mathematics and dynamic-system analysis for engineers.



Foundry Shakeout

Foundry shakeout is mounted to support structure by four vibration-isolation mountings. Schematically, system consists of a force-excited rigid mass resiliently connected to a springy foundation. Both the resilient mounting and the foundation have built-in damping action.



tial equations. This fact alone is justification enough for the method.

When differential equations are used to determine system response, analysis is usually limited to systems which can be described by linear differential expressions with constant coefficients. This category includes all mechanical systems composed of linear, time-invariant components, such as springs, masses, etc., which are driven by one or more exciters. Even though this class of problems is only a small portion of the total possible combinations encountered in general analysis work, it represents a major segment of the practical problems faced in dynamic studies and vibration analyses. Many problems which do not fall directly into this limited class may be simplified by restricting the operating region under consideration to give an approximately linear system.

The mobility method is valid for all of the systems just described. However, in this article, attention will be given only to the response of mechanical systems with linear, time-invariant components (constant characteristics) which can be defined in terms of mechanical mobility.

Basic Definitions: Mobility of a mechanical device, such as a mass, spring, damper or any combination of these elements, is defined as the ratio of the velocity across the device to the force through it. Practically, mechanical mobility is the velocity across a device produced by a unit force. As the term implies, mobility is simply a measure of the ease with which a device moves.

Consider a typical mechanical system, such as the simple, single degree of freedom arrangement shown in Fig. 1*a* in classic form. This system consists of a mass supported by a spring with a viscous damper across the spring. The system is restrained so that it can move in only the vertical direction and is excited by some arbitrary forcing

function $f(t)$. An example of this type of system might be an automobile engine which uses a coil spring and damper and is excited by torque pulsations from the engine.

Four elements complete this system: An exciter or forcing function, a mass, a spring, and a damper. The same holds true for the equivalent rotational system, Fig. 1*b*. This system consists of an inertial load, J, supported by a torsion spring member with a rotational viscous damper across the spring. The inertial load, which is equivalent in function to the mass of the translatory system, is excited by a sinusoidal torque input.

Logically, the elements in these systems separate into two classes: 1. Active elements which are energy sources or exciters. 2. Passive elements which are masses (or inertias), springs, and dampers. Any practical mechanical system, however complicated, can usually be reduced to a combination of these elements. Functions of the various elements can be defined in fairly specific terms.

Passive Elements: For translational systems, three linear, time-invariant components can be classified as passive elements:

1. *Spring:* A mechanical-energy reservoir in which the energy may be stored or released depending upon the exact dynamic condition of the spring. The characteristics of the spring are described by spring rate K, or compliance $L = 1/K$.

2. *Damper:* An energy sink in which a nonreversible transformation of mechanical energy into heat takes place. Damping force is proportional to velocity.

3. *Mass:* A mechanical-energy reservoir in which mechanical energy may be stored or released depending upon dynamic conditions. It supplies a specific force per unit of applied acceleration.

Active Elements: In addition to the passive linear elements, there are generally two active translational elements. These elements are energy sources

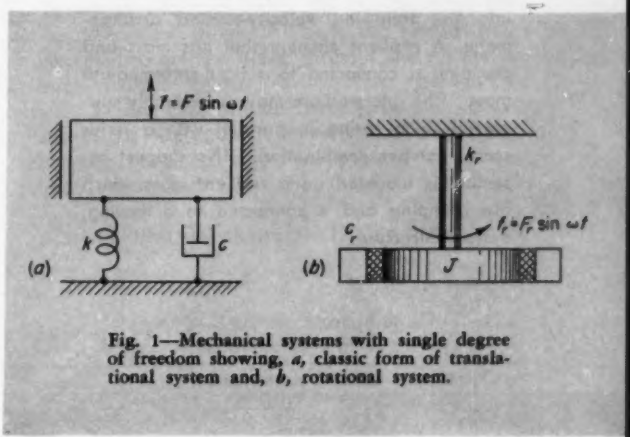
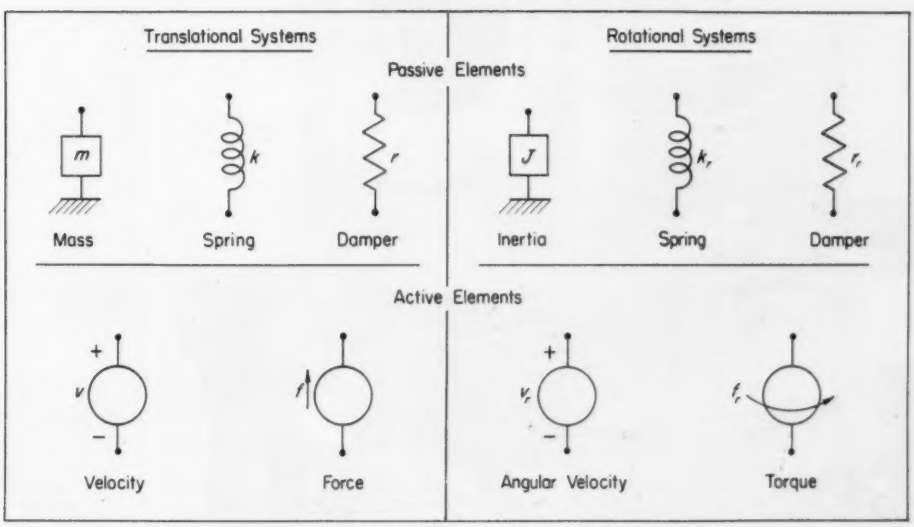


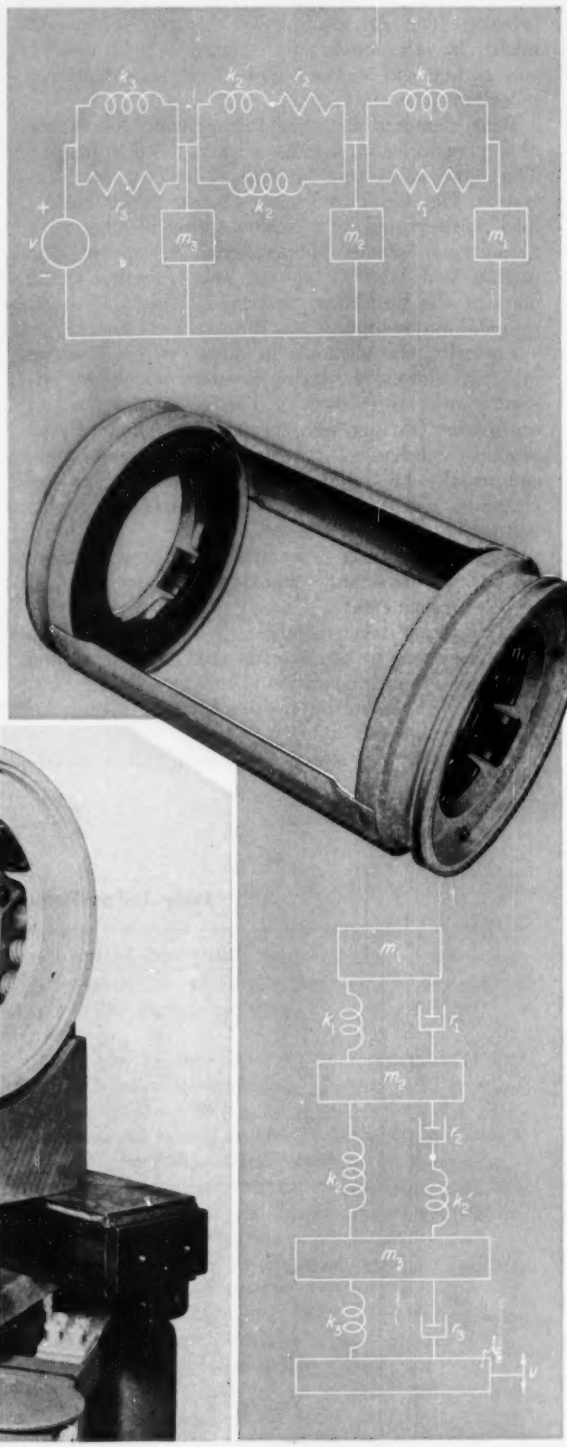
Fig. 1—Mechanical systems with single degree of freedom showing, *a*, classic form of translational system and, *b*, rotational system.

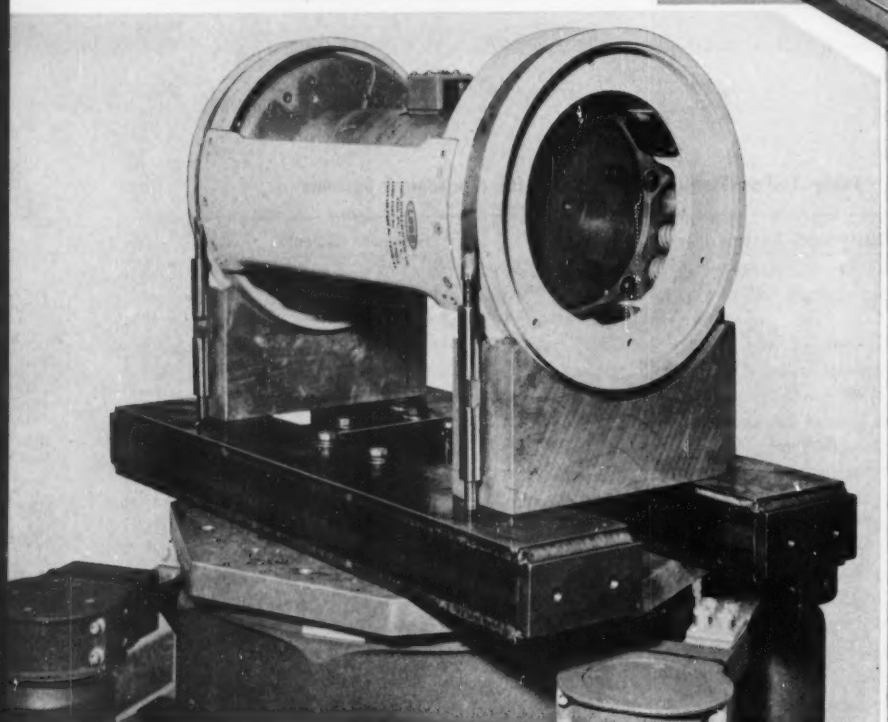
Table 1—Two-Terminal Equivalents for Mechanical Systems



Atlas ICBM Mounting System

Canister-type mounting system supports control equipment in the Atlas ICBM. It consists of two end rings which contain the vibration isolation components and are held in position by two tie beams. The entire assembly fits on specially shaped cradle blocks and is kept rigidly in place by heavy steel straps that hold the end rings tightly against the mounting cradles. Entire vibration isolator and electronic unit can be removed quickly from supporting structure by simply loosening two bolts. Schematically, the system can be broken down into the following velocity-excited arrangement: A resilient element that has mass and damping is connected to a rigid intermediate mass. The intermediate mass is resiliently supported by a spring in parallel with a series spring-damper combination. This support assembly is mounted on a resilient mass which has damping and is connected to a moving, massive structure.





or exciters and transmit either force or velocity. Only idealized constant-velocity or constant-force sources will be considered here. That is, a force source will maintain a constant force regardless of the velocity drop across it, and a velocity source will maintain a constant velocity regardless of the force through it.

A similar breakdown of passive and active elements can be readily developed for rotational systems.

Network Diagrams: These elements must now be combined into a schematic representation, or circuit diagram, of the system under consideration. This pictorial diagram is merely an analog of the exact system.

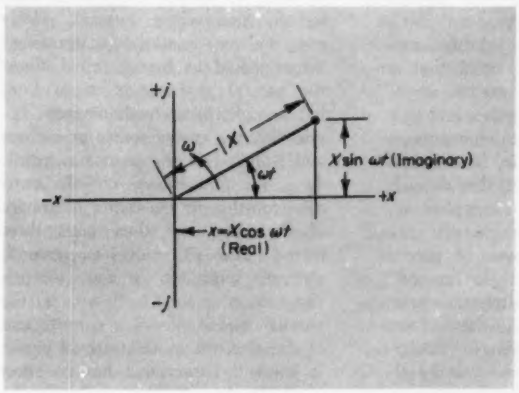


Fig. 2—Sinusoidal function represented on the complex plane. Vertical axis is imaginary, horizontal axis is real. Instantaneous position of vector represents a complex number with real and imaginary components.

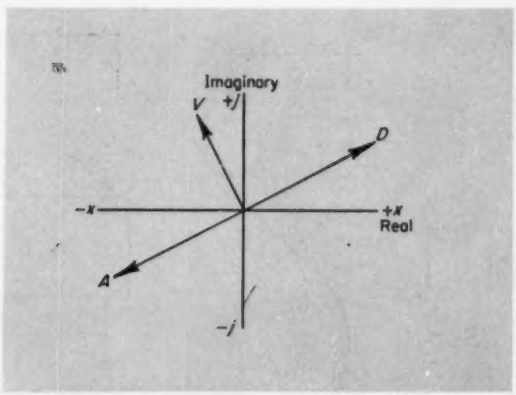


Fig. 3—Relationship of displacement, velocity, and acceleration vectors on complex plane. Each differentiation of the displacement vector advances the vector position 90 deg in the counterclockwise direction.

Symbols developed specifically for use in such diagrams are given in Table 1 for each of the passive and active elements previously discussed. Two sets of matched symbols are provided, one for translational systems and one for rotational systems. Note that each of these symbols, or analogs, is represented as a two-terminal device.

With the symbols given in Table 1, network pictures or circuit diagrams can be readily developed for mechanical systems. Principles of circuit layout are summarized for translatory systems in *How to Draw Mechanical Circuit Diagrams.* Rotational systems may be handled in the same manner.

In circuit diagrams using the two-terminal form of representation advocated here, the various paths taken by the exciting force through the system are clearly shown. Velocity distribution through the system is also easy to see. These force and velocity distributions are not so apparent in conventional schematic diagrams since the ground or inertial reference is implied.

Mathematical Relationships: The next step in the

Table 2—Exciting Functions for Mechanical Systems

Function	Instantaneous Value	Amplitude
Displacement	$d = De^{j(\omega t+\phi)}$	D
Velocity	$v = \frac{d(d)}{dt} = Ve^{j(\omega t+\phi)}$	$V = j\omega d$
Acceleration	$a = \frac{d^2(d)}{dt^2} = Ae^{j(\omega t+\phi)}$	$A = -\omega^2 d$
Force	$f = Fe^{j(\omega t+\phi)}$	F

Nomenclature

A, a = Acceleration, in. per sec
D, d = Displacement, in.
e = Natural logarithm base
F, f = Force, lb
j = Imaginary operator
= $(-1)^{1/2}$
J = Inertia, in.-lb-sec^2
k = Translational spring gradient or rate, lb per in.
k_r = Rotational spring gradient or rate, in.-lb per rad
M = Mobility
m = Mass, lb-sec^2 per in.
r = Translational viscous responsiveness, in. per lb-sec
r_r = Rotational viscous responsiveness, rad per in.-lb-sec
t = Time, sec
V, v = Velocity, in. per sec
ϕ = Phase angle, rad
ω = Angular frequency, rad per sec

How to Draw Mechanical Circuit Diagrams

In theory and in practice, mechanical circuit diagrams are analogous to their electrical counterparts. The same general principles of circuit layout and analysis apply to both; however, there are fundamental differences in interpretation and terminology. No attempt will be made here to relate the two approaches but, rather, attention will be focused only on the requirements for analysis of mechanical systems by mobility techniques.

The first step in setting up the mechanical circuit is to draw a sketch, showing schematically the physical arrangement of all of the elements in the actual system. From this sketch, the transition to the circuit diagram can be accomplished either directly in one step or, if necessary, in two steps, using an intermediate diagram to aid visualization. Both techniques will be demonstrated.

Consider the simple single degree of freedom system shown at *a*. To find the intermediate diagram, *b*, simply replace the actual system components directly with their two-terminal equivalents (Table 1). Then, rearrange this diagram to more conventional form to give the final circuit diagram, *c*.

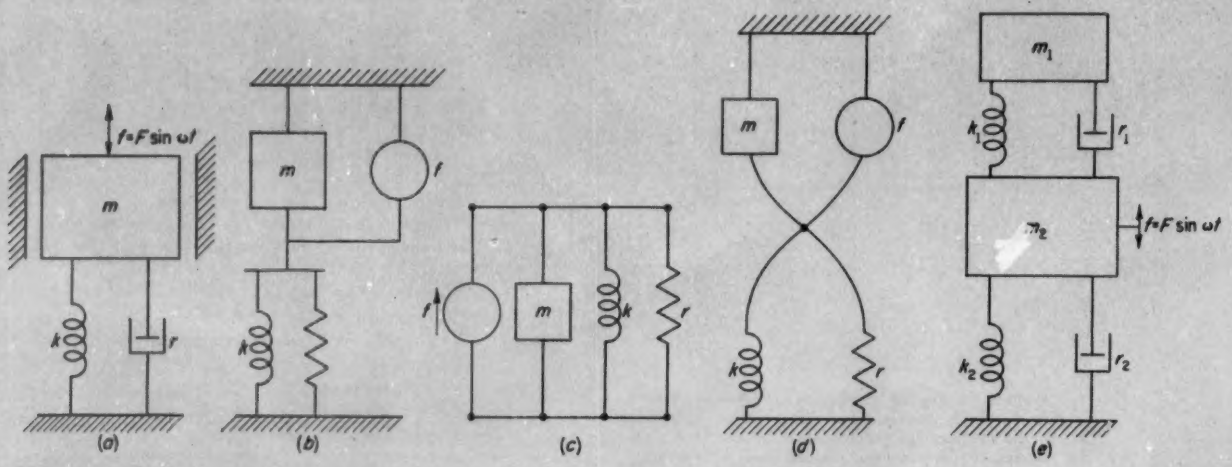
In this transition process, the mass element plays a key role. To have identity, a mass must always be considered in terms of an inertial reference (the ground, earth, etc.). Thus, in the two-terminal system of representation used here, one terminal of a mass must always be connected to the inertial reference or, borrowing from electrical terminology, to ground.

As a guide in setting up intermediate diagrams, the following procedure is recommended:

1. Replace all passive elements in schematic layout first, keeping in mind that each mass must go to ground and that all elements are two-terminal connections.
2. Analyze force or velocity function keeping in mind that a force must act against something from a reference and that each component represents a velocity drop. In force-excited systems, force must flow through each element in a complete circuit. Some force action may occur at the center of gravity of a mass where the "ground" then becomes the reference point (for example, unbalance force in an engine). Also, in velocity-excited systems the velocity always goes across an element. Here again, the circuit must be complete.

These relationships are illustrated at *b*. One terminal of the mass goes to ground. The force, which acts through the center of gravity of the mass, is connected to the other terminal and goes to ground to complete the circuit. Since the spring and damper also act at the center of gravity of the mass, all three passive elements are being affected simultaneously by the force. Thus, the intermediate diagram might also be drawn as at *d*.

For the circuit diagram, a slightly different procedure is required than for the intermediate diagram. However, the same relationships mentioned before should be kept in mind. Since the natural tendency is to go from left to right in a circuit diagram, begin with the energy source or exciters and work on to the passive elements. At *c*, the force flows into the common junction at the center of gravity of the mass and then takes three paths: Through mass to ground, through spring to ground, through damper to ground. Result is the parallel circuit shown. Arrangement of the elements in this type of circuit is purely arbitrary and has no effect on the final result.



Consider now a more complex system, such as a simple dynamic vibration absorber, *e*. The intermediate diagram appears at *f*. The arrangement for elements m_2, k_2, and r_2 is the same as at *b* and *d*. In addition, m_2 is connected to m_1 through spring k_1 and damper r_1. Mass m_1, by convention, must go to ground. The connection between m_1 and m_2 illustrates another simple rule of practice. When masses are separated by passive elements, the mass-to-mass connection must be in series.

Thus, force enters at the common junction of m_2, k_2, and r_2 and takes these paths: Through m_2 to ground, through k_2 to ground, through r_2 to ground, through k_1 and r_1 to m_1, and through m_1 to ground. The final circuit diagram is shown at g.

To illustrate the direct approach to final circuit development consider the velocity-excited system at *h*. This sketch might represent an engine mounted to a moving structure, where m_3 is the mass of a component resiliently supported on the engine by a damped spring, k_3 and r_3. Mass of the engine m_2, which is excited by a sinusoidal force, is supported by a damped resilient mounting, k_2 and r_2, on a base with mass m_1, resilience k_1, and damping r_1. Movement of the supporting structure imparts a sinusoidal velocity excitation to the base.

To draw the circuit diagram directly, begin with the velocity excitation and work across the system in three sections, as shown at *i*.

For the first section, consider only k_1, r_1, and m_1. In systems involving a moving "platform" as the source of velocity excitation for a frame structure with inherent resilience and damping, the connection must be considered on a mass-to-mass basis. This relationship is generally true for most instances of velocity excitation and gives an accurate picture of the actual system conditions.

In this first section, then, the parallel combination of r_1 and k_1 is in series with m_1 which, by convention, must be in parallel with the velocity exciter to form a complete circuit. Total velocity excitation divides proportionally across these elements and the rest of the system. That is, the velocity across m_1 acts as the velocity excitation for the rest of the system.

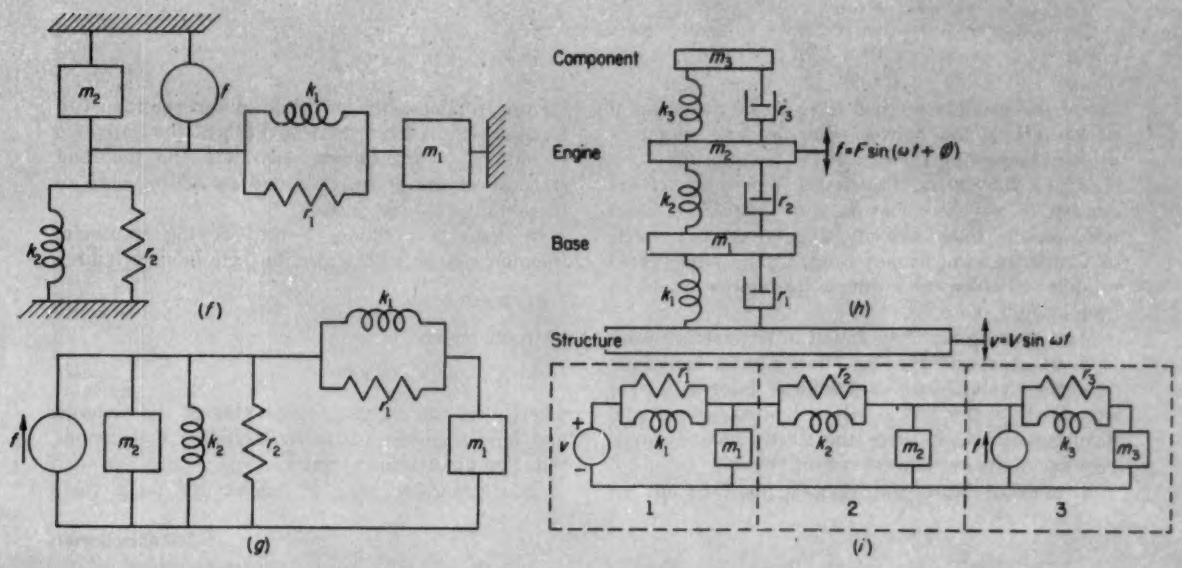
For the next section, take elements r_2, k_2, and m_2, ignoring the force excitation temporarily. This section is a straightforward mass-to-mass connection with the parallel combination of r_2 and k_2 in series with m_2. Here again there is a proportional velocity division between the elements in this section and the remaining loop in the circuit. That is, the velocity across m_2 acts as the velocity excitation for the final loop in the circuit.

The final loop consists of elements r_3, k_3, m_3, and the force exciter. As in the previous section, the arrangement of the passive elements here is based on a mass-to-mass connection.

The position of the force exciter has been selected arbitrarily. Logically, it could have also been located between m_2 and the parallel combination of r_2 and k_2. Since the exciting force acts through the same junction (center of gravity of m_2) as the spring-damper combinations on either side of m_2, the exciter must be in parallel with m_2 and m_3 to form a complete circuit.

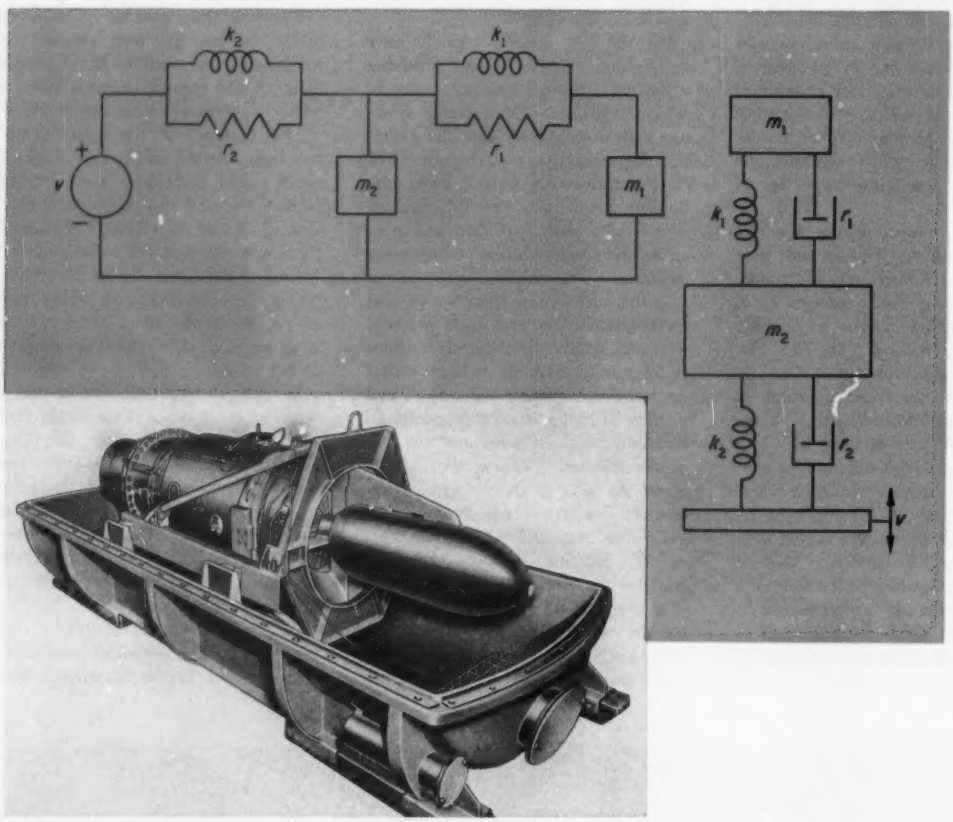
In this circuit, two sets of forces must be considered. One set is generated by the force exciter, the other by the velocity drops across the system elements. In analysis, the principle of superposition would have to be employed, considering each exciter separately and then summing up the separate solutions at each element to find the resultant.

Additional examples of circuit diagrams of actual mechanical systems are illustrated in the accompanying text.



Shipping Container Suspension

Shipping container suspension uses four elastomeric mountings to "float" sensitive or fragile equipment. Schematically, the system consists of a rigid mass which is resiliently connected to a massive container by a damped spring. The container also has characteristics of damped spring. The input is a velocity disturbance at the base of the container.



use of the mobility method is to define the physical parameters in the network diagram and to establish sign conventions.

Active Elements: Practically, the source of excitation in a system may be any generalized function, such as linear velocity, angular velocity, force, or torque. In form, it may range from a complicated random vibration to a simple periodic sinusoid or even a single pulse.

Most exciting functions found in engineering work may be represented by a Fourier-series expansion of harmonic functions or a Fourier integral expansion. Scope of this article will be limited to sinusoidal disturbances which cover the steady-state dynamic response of the mechanical system.

If multiple sinusoidal components exist in the exciting function, the principle of superposition can be used with a linear system. Each of the harmonic excitations is investigated separately and the total response of the system is found by adding each of these individual responses.

In complex notation, a time-varying sinusoidal function can be represented by (see Nomenclature)

$$x = Xe^{j\omega t} \tag{1}$$

or its equivalent

$$x = X(\cos \omega t + j \sin \omega t) \tag{2}$$

where x is the instantaneous value of the sinusoid and X is a complex quantity including both amplitude and phase information.

This expression may be represented on a com-

plex plane, Fig. 2, where a vector of finite length $|X|$ is rotating about the polar axis at angular frequency ω in the counterclockwise direction. Any instantaneous position of this vector represents a complex number of the form given by the right-hand terms of Equations 1 and 2. Either the real or imaginary portion of the complex vector is used. In the complex plane, the horizontal projection of the complex vector is $x = X \cos \omega t$ and the vertical projection is $x = X \sin \omega t$. Therefore, either a sine or cosine excitation may be chosen simply by taking the real or imaginary portion of the final expression for the system response.

Conventional practice, however, is to indicate simple harmonic motion by the complete vector notation. This convention is well established in the literature and has been followed here, as demonstrated in Equations 1 and 2 where x represents the real value of the sinusoid at any instant of time.

In the treatment of time-varying vectors here, instantaneous values of vectors will be identified by lower-case letters, peak magnitudes by capital letters. Phase relationships will be explicitly noted by including the term $e^{j\phi}$ where required.

For mechanical systems, exciting functions usually take the form of simple harmonic displacement, velocity, acceleration, or force. These vibratory disturbances may be defined in terms of the real or imaginary part of a complex vector as shown in Table 2.

Displacement amplitude D is a constant which represents the maximum displacement or single amplitude of the excitation. Angle ϕ represents the phase angle of the displacement and identifies the point in the cycle where the motion starts at $t = 0$.

The velocity and acceleration vectors may be obtained by successive differentiation of the displacement vector. The phase angle remains constant but, with each differentiation, the vector advances 90 deg in the counterclockwise direction. The complex-plane plot of the displacement, velocity, and acceleration vectors is shown in Fig. 3. If any one of these three quantities is known, the other two

Table 3—Complex-Vector Forms of Exciting Functions

Ideal Source	Mathematical Form	Real Component	Imaginary Component
Velocity	Translational Systems		
	$v = Ve^{j\omega t}$	$v = V \cos \omega t$	$v = V \sin \omega t$
Force			
	$f = Fe^{j\omega t}$	$f = F \cos \omega t$	$f = F \sin \omega t$
Angular Velocity	Rotational Systems		
	$v_r = V_r e^{j\omega t}$	$v_r = V_r \cos \omega t$	$v_r = V_r \sin \omega t$
Torque			
	$f_r = F_r e^{j\omega t}$	$f_r = F_r \cos \omega t$	$f_r = F_r \sin \omega t$

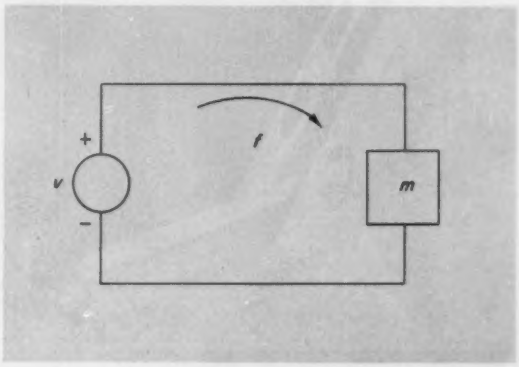


Fig. 4—Relationship of velocity and force flow in a mechanical circuit with a single mass element.

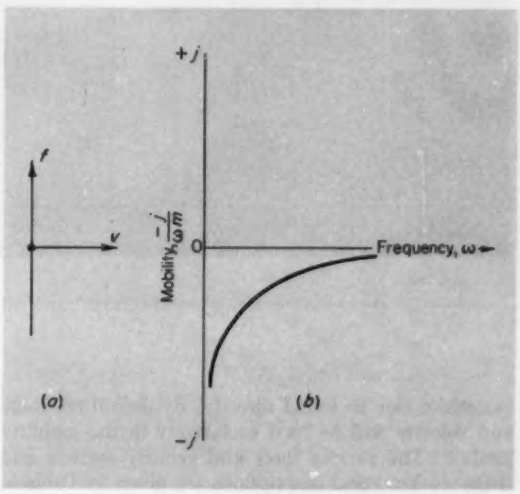
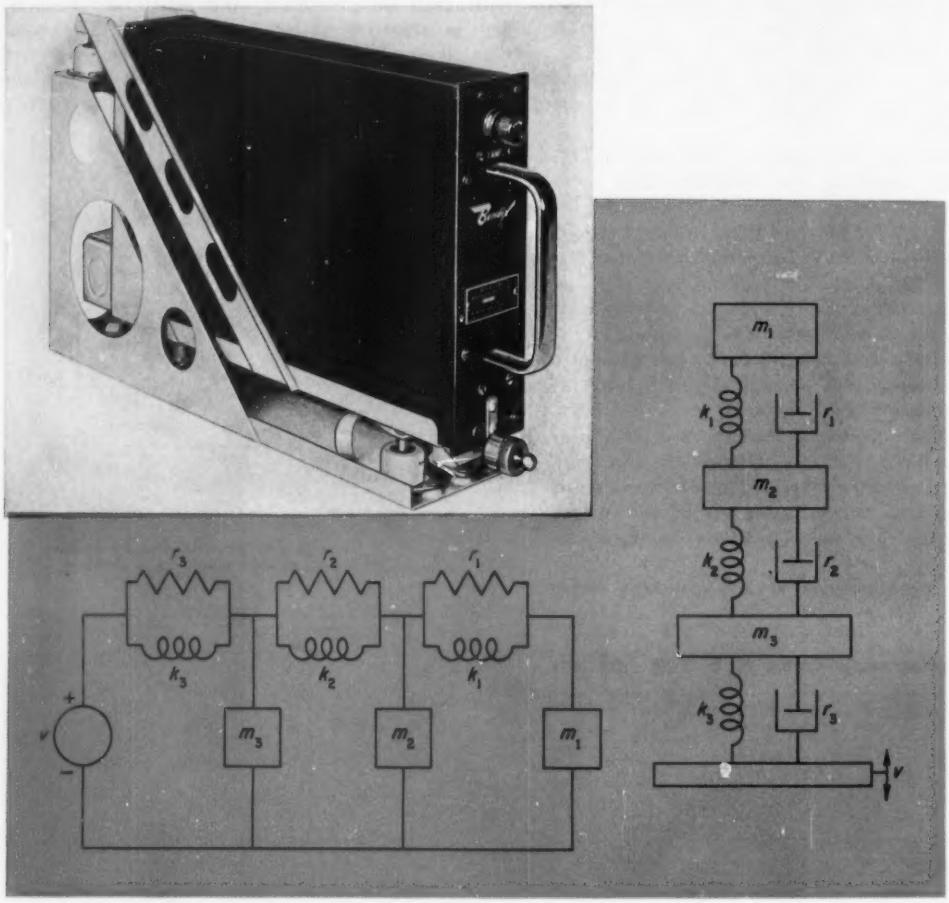


Fig. 5—Basic relationships for mass elements: *a*, Force and velocity; *b*, mobility and frequency. At *b*, curve plot shows that mass is easy to move at low frequencies (high mobility) but becomes difficult to move at high frequencies (low mobility).

Airborne Equipment Mount

Standard mounting base for airborne radio equipment has equipment retainer base supported on damped resilient mounts in base frame. Schematically, when base is mounted in aircraft with equipment clamped in place, system consists of a resilient element, having mass and damping, which is connected to a rigid mass supported on a moving structure by a damped spring. Acting as a velocity exciter, the moving structure has resilience, mass, and damping.



quantities can be found directly. By definition, force and velocity will be used exclusively in the mobility method. The various force and velocity exciters and their mathematical descriptions are given in Table 3.

Passive Elements: Mathematical expressions for the fundamental mechanical elements of mass, spring rate, damping, etc., may be developed directly from basic definitions. Each of these fundamental elements has been defined as a two-terminal device. A force or torque must flow through the element from one terminal to the other. The velocity associated with the element will be defined as the velocity across it.

In any network, then, the force will flow from point to point because of the velocity difference between two points, regardless of what is in the flow-

path. Direction of the force or torque in the circuit diagram shall arbitrarily be taken as the direction of the applied force or torque in the actual system being studied.

The sign of the velocity across an *active* element shall be taken as minus to plus in the direction of the force flow. The sign of the velocity across *passive* elements shall be taken as plus to minus in the direction of force flow.

Consider a mass element excited by a constant-velocity source. The amount of the mass determines the force through the element for a given rate of change of velocity across the terminals of the element. Mathematically, $f = m\ (dv/dt) = ma$ or, simply, Newton's second law. Now, assume a positive sinusoidal velocity, $v = Ve^{j\omega t}$, is applied across the mass, Fig. 4. A force f will flow through the mass in the direction shown. Applying Newton's second law,

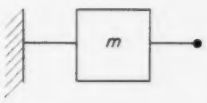
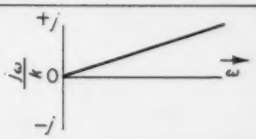
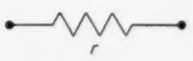
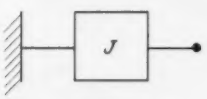
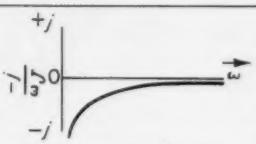
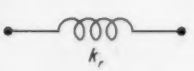
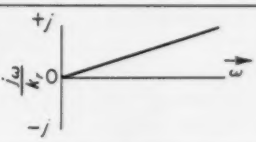
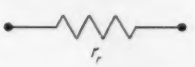
$$f = m\frac{dv}{dt} = j\omega mVe^{j\omega t} = j\omega mv \tag{3}$$

where

$$\frac{dv}{dt} = j\omega Ve^{j\omega t} \tag{4}$$

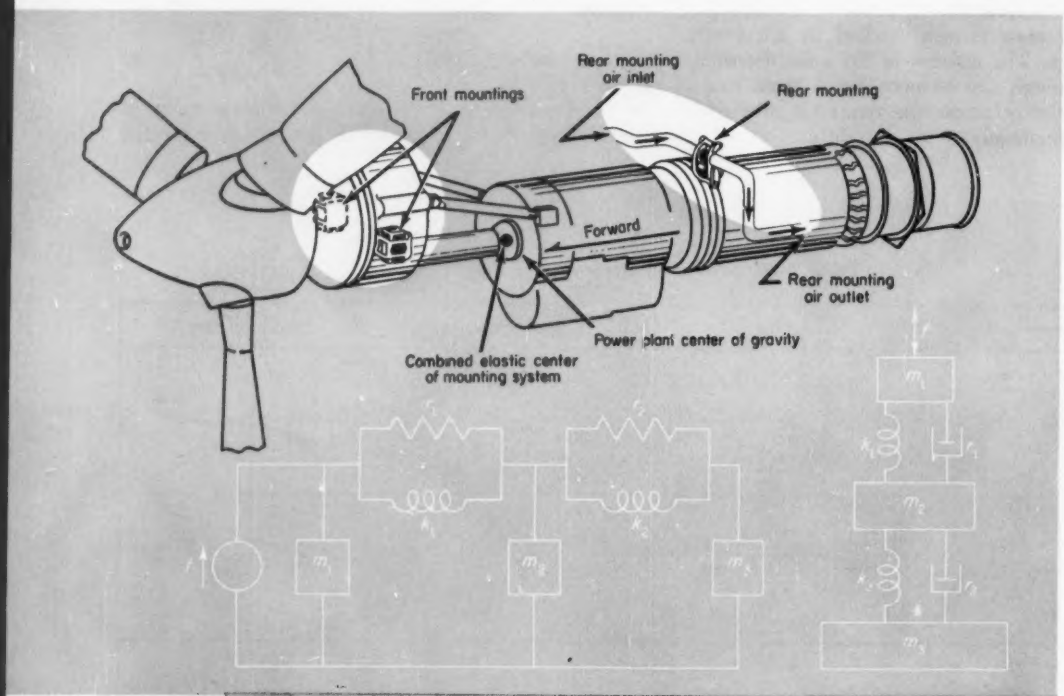
In Equation 3, a constant of proportionality is established between the force flowing through the

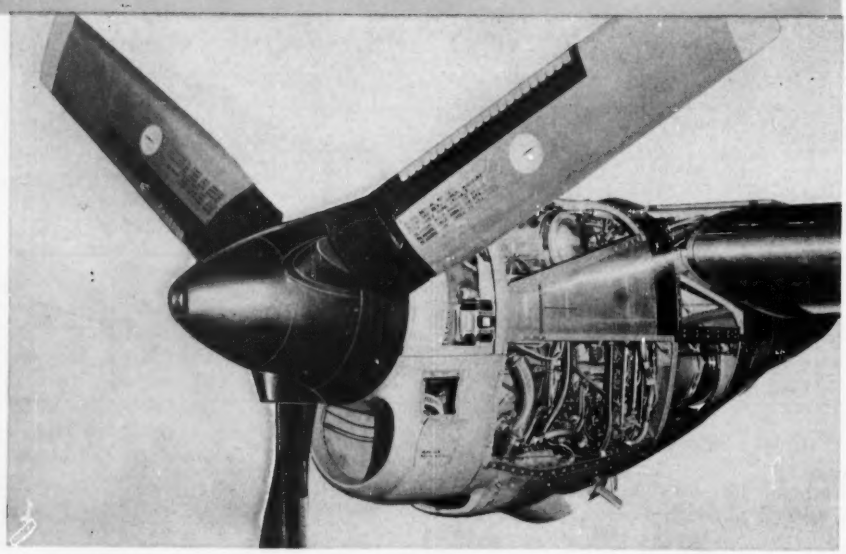
Table 4—Mobilities of Mechanical Elements

Element	Symbol	Mobility	Frequency Plot
Translational Systems			
Mass		$\frac{-j}{\omega m}$	
Spring		$\frac{j\omega}{k}$	
Damper		r	
Rotational Systems			
Inertia		$\frac{-j}{\omega J}$	
Spring		$\frac{j\omega}{k_r}$	
Damper		r_r	

Aircraft Engine Suspension

Aircraft engine is elastically mounted on three-point suspension so designed that the elastic center of the mountings coincides with the center of gravity of the engine. Schematically, system consists of a force-excited rigid mass connected by a damped spring to a resilient frame, having mass and damping, which is connected to a massive structure.





mass and the applied velocity. If the velocity is now divided by the force, this constant, which represents the mobility of the mass, is separated. From Equation 3,

$$M_m = \frac{v}{f} = -\frac{j}{\omega m} \qquad (5)$$

where M_m, the mobility of the mass, is a complex number, containing both magnitude and phase information. The magnitude of the force is always ωmv and the force through the mass leads the velocity by 90 deg. The phase relationship between force and velocity is shown in Fig. 5*a*, and the relationship between mobility of the mass and frequency in Fig. 5*b*.

Mobility relationships for all of the common mechanical elements may be developed in a similar manner. These relationships are summarized in Table 4.

Where convenient, mobilities may be considered as pure mathematical expressions, or complex vector operators, and plotted on a complex plane. The graphical relationships for both rotational and translational systems are shown in Fig. 6.

These mobility diagrams give the vectorial relationships of the various passive mechanical system elements on the complex plane. The mobilities for springs lie along the positive imaginary axis, the mobilities for masses and inertias along the negative imaginary axis, and the mobilities for dampers along the positive real axis. Energy dissipation can take place only along the real axis, and energy storage only along the imaginary axis.

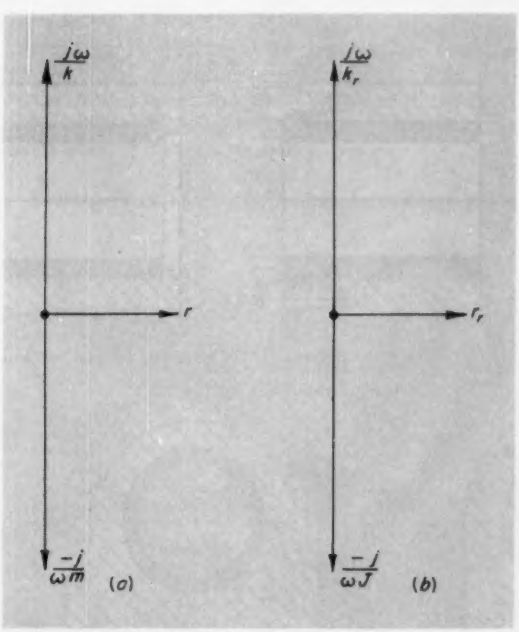


Fig. 6—Relationship of complex vectors representing mobilities for passive mechanical elements in, *a*, translational systems and, *b*, rotational systems.

The mobility expressions are the solutions to the differential equations of motion for the individual elements. When assigned to the physical elements of a system, they represent the resultant magnitude change and phase shift that occur between force and velocity at the element. Hence, mobilities describe the complete dynamic-response properties of the mechanical elements in terms of both force and velocity. They provide a powerful tool for solving problems that would be extremely difficult or impractical to handle by classical techniques. When the individual mobility expressions are properly combined, analysis of multiple degree of freedom systems often can be greatly simplified.

Impedance Method: The concept of mechanical mobility is the basis of the method of analysis presented here. A parallel concept, mechanical impedance, is the basis of another method that is widely used. Essentially, one system is merely the reciprocal of the other.

Mathematically speaking, the choice of which method is best is mainly a matter of personal preference, with two exceptions. For problems involving electromagnetic-mechanical systems, the mobility method must be used. For problems involving electrostatic-mechanical systems, the impedance method must be used.

In the author's opinion, the mobility method offers certain advantages. Practically, the foremost feature of this method is the topological correspondence which exists between schematic diagram and actual system. That is, springs in parallel in the physical system are represented by spring mobilities in parallel in the equivalent circuit, and so on. However, with the impedance method, springs in parallel in the physical system are represented by springs in series in the circuit diagram.

Nevertheless, the two systems are mathematical duals and can be used interchangeably without affecting the final answer. Often, certain types of calculations can be simplified by changing from one form to the other.

The second and concluding article of this two-part series will show how the mobility method can be applied to the analysis of mechanical networks.

Bearing

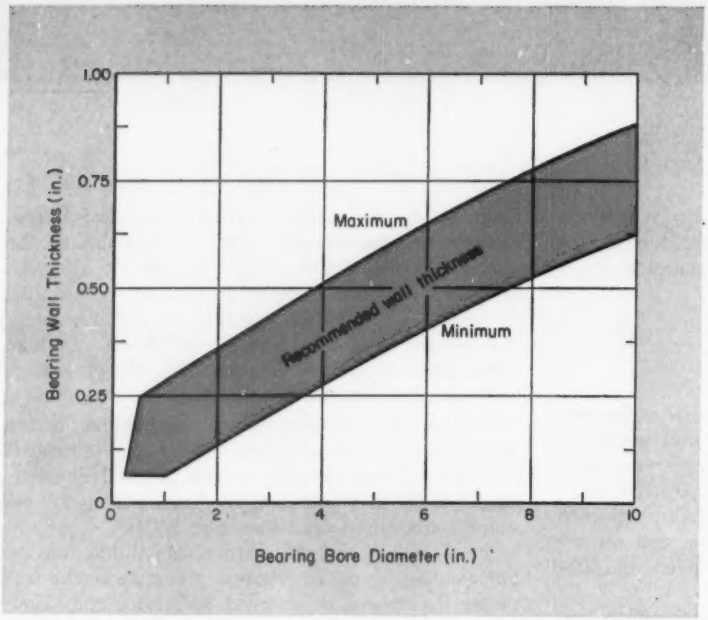


Fig. 54—Range of recommended wall thicknesses for cast bronze sleeve bearings as determined by bearing bore diameter. For bearings larger than 10-in. diameter, specific manufacturers should be consulted.

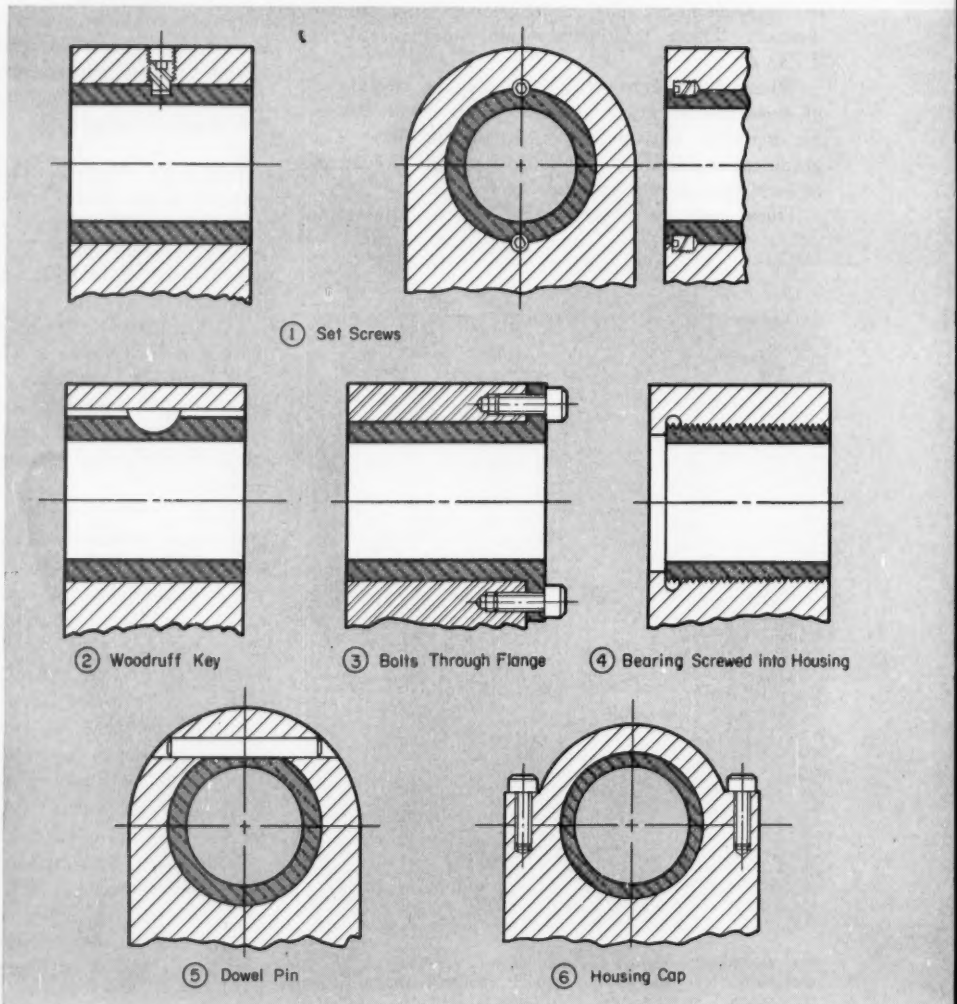


Fig. 55—Common methods used to prevent movement of bearing within the housing.

DESIGN MANUAL: Cast Bronze Sleeve Bearings/No. 6

Fabrication and Assembly

HARRY C. RIPPEL, Senior Research Engineer
The Franklin Institute Laboratories, Philadelphia

LIKE any other engineering problem, the major efforts in designing a bearing must be concluded with small but common-sense details. Without such practical considerations as proper installation or compatibility with other operating parts, even a perfect bearing could fail.

Wall thickness of the bearing, the type of housing material, and methods of retaining the bearing within the housing are some of the final, and often interrelated, points to be specified. Proper relationship between bearing and journal hardnesses must be established to prevent rapid wear and expensive replacement. Surface finish is also important in controlling wear. And after the bearing has been assembled and placed in service, maintenance personnel will need information about care of the bearing and its lubricating accessories and about replacement when it becomes necessary.

Bearing Wall Thickness: Bronze sleeve bearings are normally contained within a housing or shell. Criteria for wall thickness is that the bearing, when installed in its housing, should provide adequate strength to support the imposed loads without elastic or thermal distortions which would destroy the "built-in" geometry of the bearing. In general, increasing wall thickness is required for increasing bore diameter. But ratio of wall thickness to bore diameter decreases with increasing bore diameter.

Thin bearing walls and heavy housings provide more strength than the opposite arrangement, but heat transfer from the bearing may be impeded. If severe wear of bearing material is permissible and expected, adequate material thickness should be provided. Anticipated temperature rise is another consideration when wall thickness is specified. Large variations in temperature, and different coefficients of thermal expansion for bearing and housing materials, combine to produce expansion and contraction forces that make bearing dimensions and fits diffi-

Table 14—Recommended Tolerances for Nominal Housing Bores Using Press or Shrink Fits

Nominal Bearing OD and Housing ID (in.)	Tolerance on Nominal Bearing OD (in.)	Tolerance on Nominal Housing ID (in.)	Range of Interference Fit (in.)	Average Interference Fit (in.)
0 to 0.5	+0.002 to +0.003	+0.0015 to +0.0020	zero to 0.0015	0.00075
0.5 to 1	+0.002 to +0.003	+0.0010 to +0.0015	0.0005 to 0.0020	0.00125
1 to 1.5	+0.002 to +0.003	+0.0005 to +0.0010	0.0010 to 0.0025	0.00175
1.5 to 2	+0.002 to +0.003	+0.0000 to +0.0010	0.0010 to 0.0030	0.0020
2 to 2.5	+0 002 to +0.003	+0.0000 to +0.0010	0.0010 to 0.0030	0.0020
2.5 to 3	+0.002 to +0.003	−0.0005 to +0.0005	0.0015 to 0.0035	0.0025
3 to 4	+0.003 to +0.005	+0.0005 to +0.0015	0.0015 to 0.0045	0.0030
4 to 5	+0.003 to +0.005	+0.0000 to +0.0010	0.0020 to 0.0050	0.0035
5 to 6	+0.003 to +0.005	−0.0005 to +0.0005	0.0025 to 0.0055	0.0040
6 to 8	+0.003 to +0.005	−0.0010 to +0.0000	0.0030 to 0.0060	0.0045

cult to maintain. Varying clearance within the bearing can result.

When a bearing is pressed or shrunk into the housing, unequal expansions can also cause stressing of both members. If the bearing material yields, cooling may change the original interference fit and result in a loose bearing. However, these difficulties may be minimized by proper design.

A final requirement, mentioned in a previous article, is that wall thickness should be at least three times the depth of any grooving used in the bearing. Suitable wall thicknesses and the amount of thickness variation allowed for cast bronze bearings are recommended in Fig. 54.

Methods of Retaining Bearings: Many different techniques are used to insure that a bronze bearing stays put within the housing. The method used depends upon the particular application but requires first that the unit lend itself to convenient assembly and disassembly. One goal to keep in mind is that the bearing wall should be uniformly thick to prevent introduction of weak points in the construction which might lead to elastic or thermal distortion.

Press or Shrink Fit: One common and satisfactory technique for retaining the bearing is to press or shrink the bearing in the housing with an interference fit. Uniform wall thickness over the entire bearing is easily maintained by either of these processes.

Standard stock bushings with finished inside and outside diameters are available in sizes up to approximately 5 in. ID. Stock bushings are commonly provided with 0.002 to 0.003 in. over nominal on OD sizes of 3 in. or less. For ODs greater than 3 in., actual OD is 0.003 to 0.005 in. over nominal. Since these tolerances are built into standard bushings, the amount of press fit is controlled by housing bore. Fits recommended for general applications are listed in Table 14.

For high-temperature work, interference fits in Table 14 may need adjusting to account for expansion differences between bearing and housing and to avoid yielding of the bearing material. Thin-walled housings or housings other than steel or cast iron require somewhat lighter press fits. For fabricated bearings, tolerances of both bearing OD and housing bore should be specified to produce the recommended interference fits.

As a result of a press or shrink fit, the bore of the bearing material "closes in" by some amount. In general, this diameter decrease is approximately 70 to 100 per cent of the interference fit. Any attempt to accurately predict the amount of close-in, in an effort to avoid final clearance machining, should be avoided.

Shrink fits may be accomplished by chilling the bearing in dry-ice and alcohol, or in liquid air. These methods are easier than heating the housing and are preferred. Dry ice has a temperature of -110 F and liquid air boils at -310 F.

When a bearing is pressed into the housing, the driving force should be uniformly applied to the end of the bearing to avoid upsetting of the bearing. Also important are the mating surfaces, which must be clean, smoothly finished, and free of machining imperfections.

Keying Methods: Many different ways are used

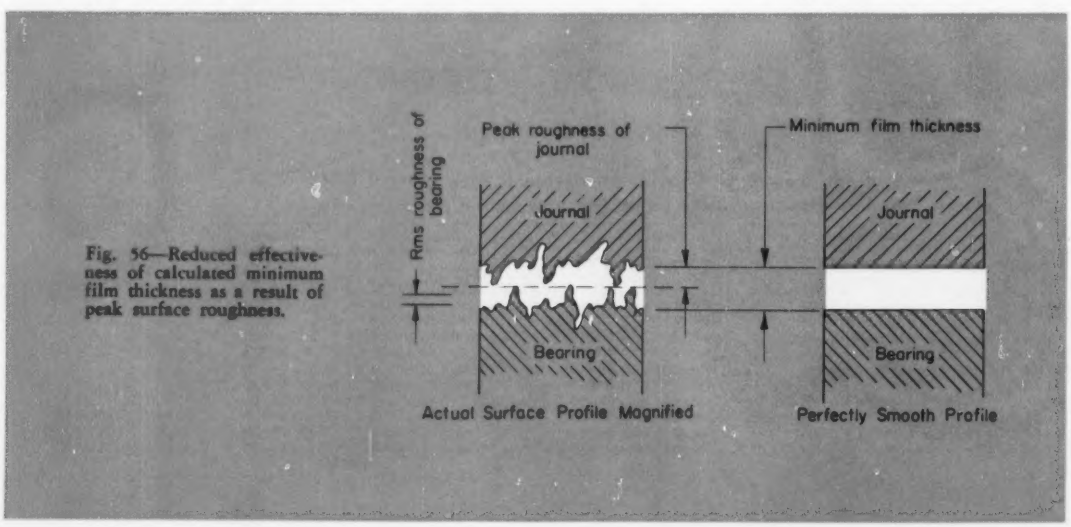


Fig. 56—Reduced effectiveness of calculated minimum film thickness as a result of peak surface roughness.

to fix the position of the bearing with respect to its housing by "keying" the two together. Possible keying methods shown in Fig. 55 include:

1. Set screws.
2. Woodruff keys.
3. Bolted bearing flanges.
4. Threaded bearing OD.
5. Dowel pins.
6. Housing caps.

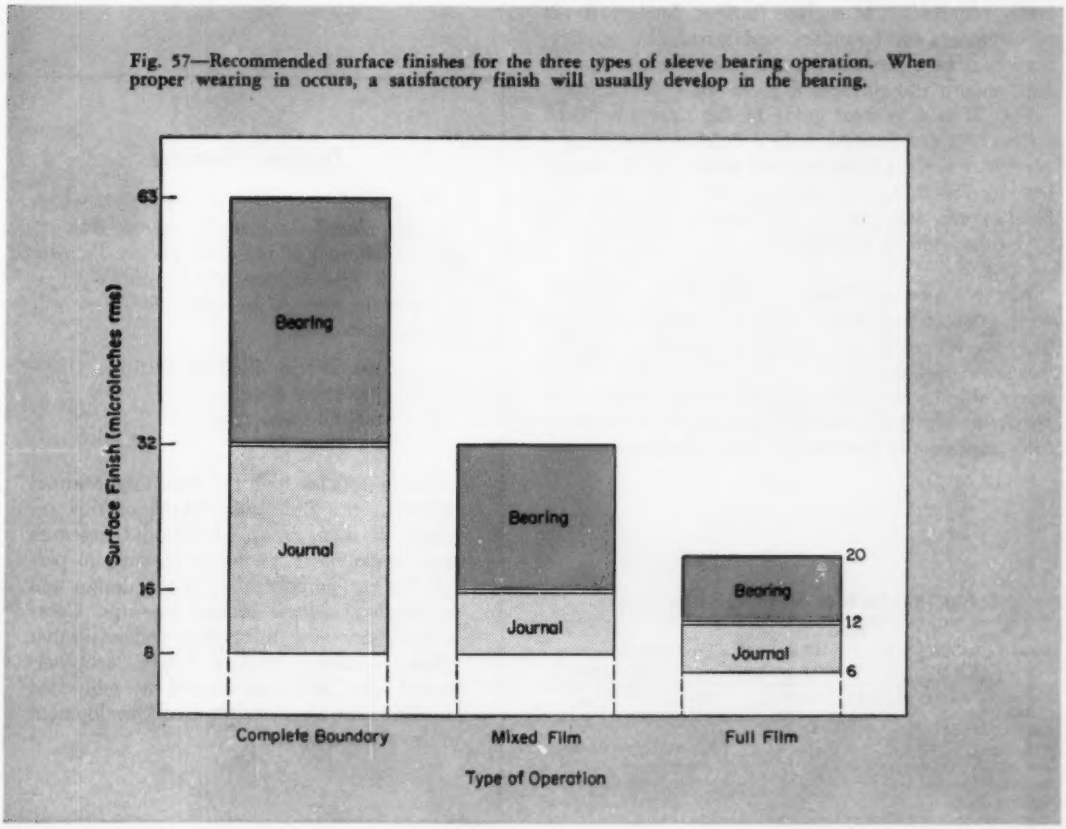
Factors to keep in mind when selecting one of these methods are:

1. Maintain uniform wall thickness of the bearing material if at all possible, especially in the load-carrying region of the bearing.
2. Provide as much contact area as possible between bearing and housing. Mating surfaces should be clean, smooth, and free from imperfections to facilitate heat transfer.
3. Prevent any local deformation of the bearing, if possible, that might result from the keying method. Machining after keying is recommended.
4. Investigate possibilities of bearing distortion resulting from the effect of temperature on the particular keying method.

Bearing and Journal Hardness: Even in well-lubricated full-film sleeve bearings, momentary contact between journal and bearing may occur under such conditions as starting, stopping, or overloading. In mixed-film and boundary-film lubricated sleeve bearings, continuous metal-to-metal contact occurs. Hence, to allow for any necessary wearing-in, the journal is usually made harder than the bearing material. This practice allows the effects of scoring or wearing to be inflicted on the more easily replaced bearing rather than on the more expensive shaft. As a general rule, recommended Brinell hardness of the journal is at least 100 points harder than the bearing material.

The softer cast bronzes are those with high lead content and very little tin. Such bronzes give adequate service in boundary and mixed-film applications where full advantage is taken of their excellent "bearing" characteristics. High-tin, low-lead content cast bronzes are the harder bronzes which have higher ultimate load-carrying capacity. Accordingly, higher journal hardnesses are required with these bearing bronzes. Aluminum bronze requires a journal hardness in the range of 550 to 600 Bhn.

Fig. 57—Recommended surface finishes for the three types of sleeve bearing operation. When proper wearing in occurs, a satisfactory finish will usually develop in the bearing.



Harder bearing materials, in general, require better alignment and more reliable lubrication to minimize local heat generation if and when the journal touches the shaft. Also, abrasives which find their way into the bearing are a problem for the harder bearing materials because they cannot readily embed themselves in the bearing as they would in a softer material. Hence, lubricant cleanliness is also a more important consideration for the harder materials. However, clean lubricant is important for the best performance of any material.

Surface Finish: Whether bearing operation is complete boundary, mixed film, or fluid film, surface finish of journal and bearing must receive careful attention. In applications where operation is hydrodynamic or full film, peak surface variations should be less than the expected minimum film thickness. Otherwise, peaks on the journal surface will contact peaks on the bearing surface, Fig. 56, with resulting high friction and temperature rise. Ranges of surface roughness obtained by various finishing methods are listed in Table 15.

In general, better surface finishes are required for full-film bearings operating at high eccentricity ratios because full-film lubrication must be maintained with small clearances, and metal-to-metal contact must be avoided. Also, harder materials generally require better surface finishes. Surface finish requirements for boundary and mixed-film applications may be somewhat relaxed since bearing wear-in will smooth the surfaces if given an opportunity.

Fig. 57 is a general guide to the ranges required for bearing and journal surface finishes. Specifying a particular surface finish in each range can be simplified by following the general rule that smoother finishes are required for the harder materials, for high loads, and for high speeds.

Maintenance and Replacement: After a suitable design has been completed and the bearing has been properly fabricated and installed, successful trouble-free sleeve bearing operation lies in the hands of those responsible for any bearing maintenance that may be required. Although this Manual is not intended to fully explore the problem of sleeve-bearing maintenance, no bearing design is entirely complete without consideration of particular maintenance requirements. Definite instructions regarding bearing maintenance should be issued to cover such items as:

1. Number and location of all bearings.
2. Specification of recommended lubricant.
3. Lubrication and inspection schedule and procedure.
4. Overhaul instructions applying to bearings.
5. Operating and maintenance instructions for accessory lubricating equipment if required.
6. Bearing replacement instructions emphasizing clearance requirements and proper installation procedure.

Properly designed and applied bronze sleeve bearings encounter difficulty for one of two reasons—either they are overworked with regard to speed and load, or they receive inadequate or faulty lubrication. Sleeve bearings, like humans, suffer when overworked, neglected, or treated badly. With reasonable care and attention, bronze sleeve bearings can, and do, fulfill a vital need in a highly mechanized age.

Table 15—Surface and Peak Roughness

Finishing Method	Surface Roughness Range (microinches rms)	Peak Roughness (microinches)
Boring, broaching, reaming, finish turning	32-63	—
Commercial grinding	16-63	—
Precision grinding	4–16	4.5 × rms roughness
Honing and lapping	4-16	6.5 × rms roughness
Polishing and buffing	2-16	7 × rms roughness
Superfinishing	1-8	7 × rms roughness

REFERENCES

Issues of MACHINE DESIGN in which previous articles appeared are:

1. "Bronze Sleeve Bearings" ..... September 17, 1959
2. "Viscosity and Lubricants" ..... October 1, 1959
3. "Sleeve-Bearing Bronzes" ..... October 29, 1959
4. "Grooving for Sleeve Bearings" ..... November 12, 1959
5. "Supplying Lubricant to Sleeve Bearings" .... November 26, 1959

Design Manual

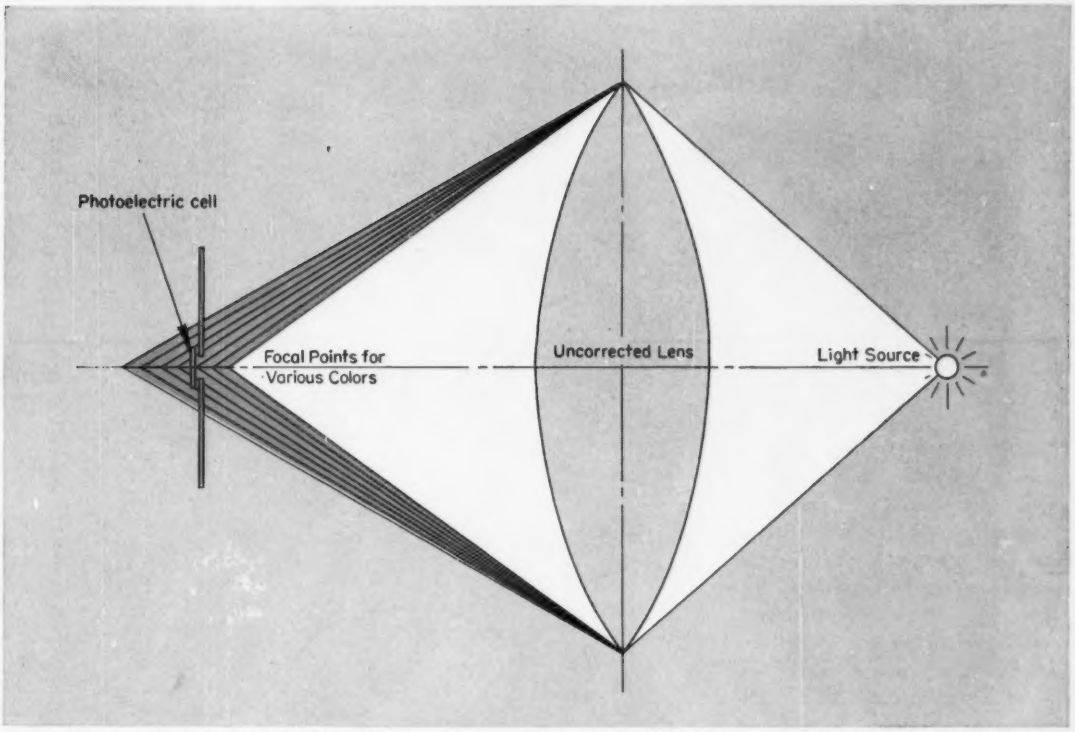
This article completes a series of six which have presented the complete Sleeve Bearing Design Manual of the Cast Bronze Bearing Institute. The articles will be published as a complete manual in early 1960 and will be available from:

Cast Bronze Bearing Institute
University Bldg.
1604 Chicago Ave.
Evanston, Ill.

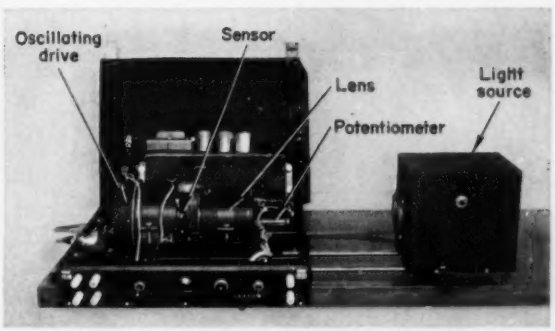
These articles and the resulting Manual represent the first undertaking of this recently formed group. Additional research and development are being planned to permit further simplification in the design and application of cast bronze bearings. Comments concerning this series, and any other phase of sleeve bearing design, are welcomed by CBBI and should be addressed to Chairman for Research and Development at the above address.

Simple Sensor Identifies Color By Locating Its Focal Point

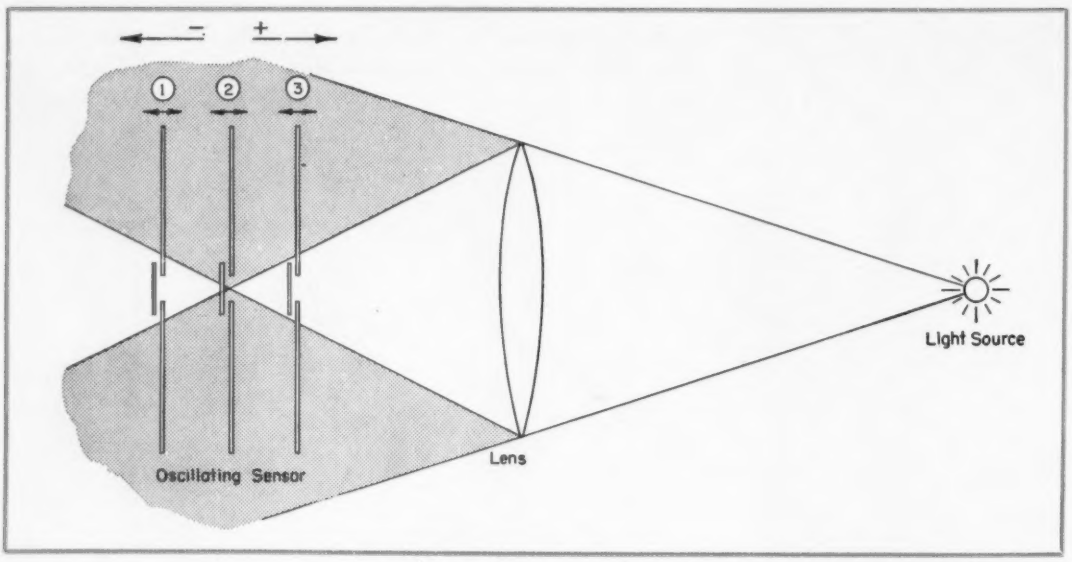
COLOR ABERRATIONS from an uncorrected lens are brought to focus at points along the focal axis corresponding to their wavelengths. The color detector uses a previously-developed ranging system to bring the dominant hue into sharp focus, and then identifies it by the distance from its focal point to the lens.



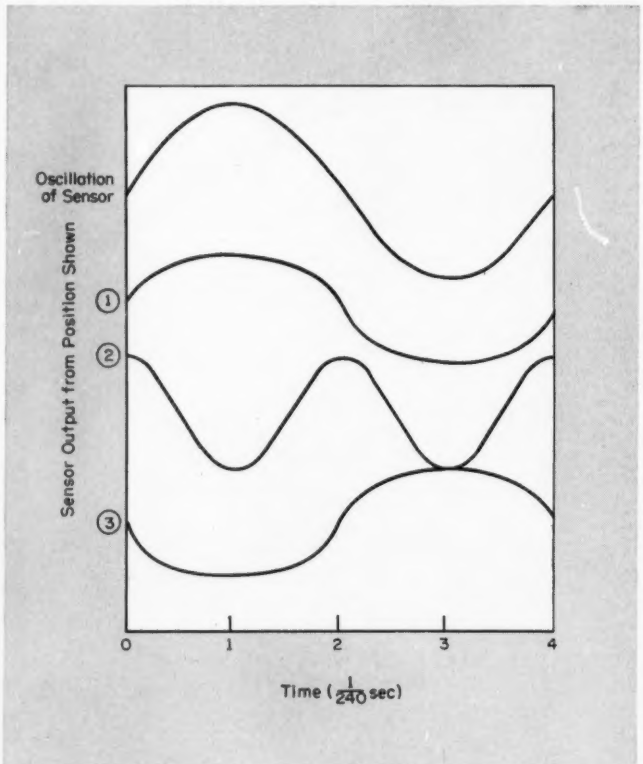
Color detecting system identifies the dominant hue in a light source far more accurately than could be done by the human eye. Comapco Inc., Encino, Calif., uses its previously developed OAR (Optical Automatic Ranging) system to focus the dominant hue in a color source through an uncorrected lense for quick identification. Comapco says the Sens-OAR-chrome system is good not only for light in the visible region but, with proper equipment, can be used for ultraviolet, infrared, and even short radio waves.



Simple Sensor Identifies Color By Locating Its Focal Point

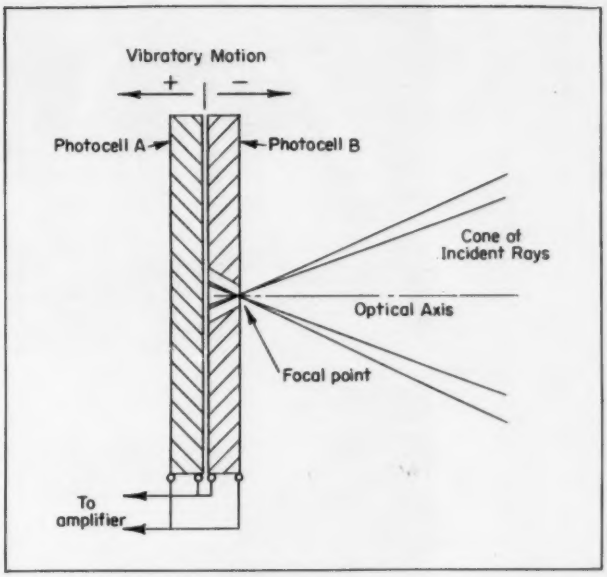


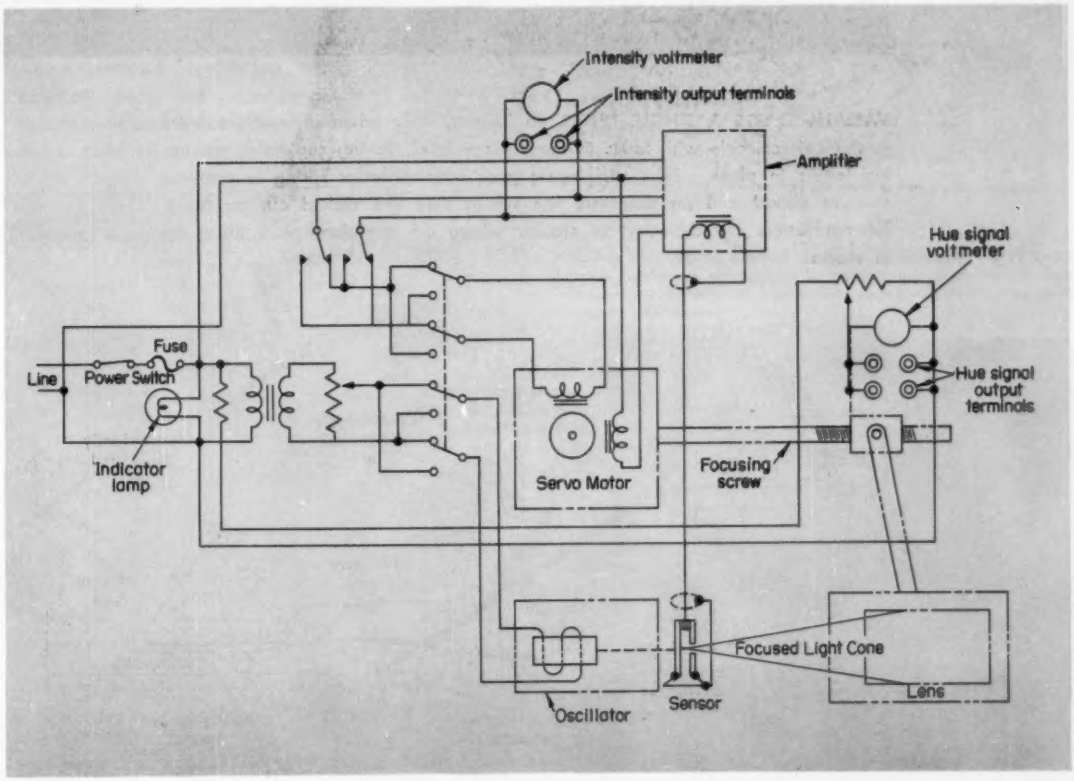
COLOR SENSOR IS FOCUSED by a servo motor in response to its signals. In position 1 or 3 the sensor receives less light because part of the light cone is blocked by the diaphragm containing the "pinhole." Movement toward the focal point increases the amount of light passing through the pinhole. The sensor is oscillated in line with the focal axis. Its output follows one of three modes depending on the location of the center of oscillation in relation to the focal point. Comparison of sensor oscillation and output directs the servo motor.



ACTUAL SENSOR uses a second photoelectric cell, B, as a diaphragm. Connecting them in opposition augments the effect of being off focus, since the signal from B, incited by light striking B, tends to cancel or contradict the signal from A. At focus on the predominant hue, B is relatively inactive, since all the light of that wavelength goes through the pinhole and strikes A.

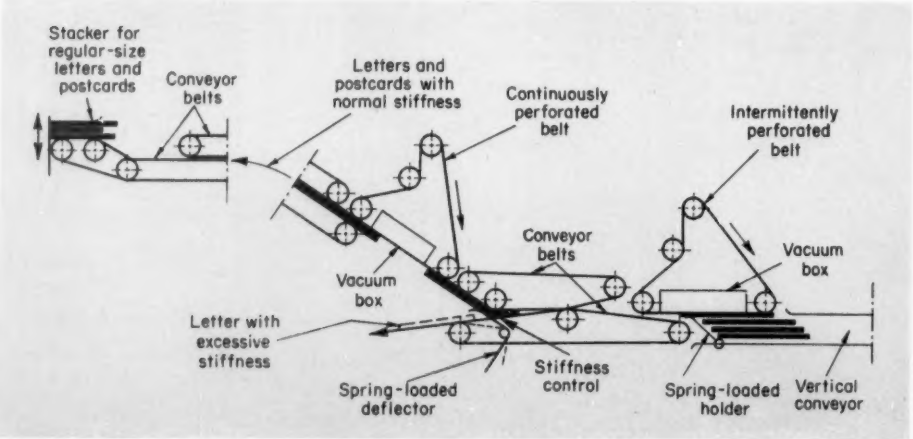
HUE IS IDENTIFIED by a voltmeter whose output corresponds in function to a focusing scale. Another voltmeter measures light intensity at the focal point. Oscillator driving the sensor is identical in construction with the drive unit of a hi-fi speaker. It's a coil moving in a strong magnetic field.

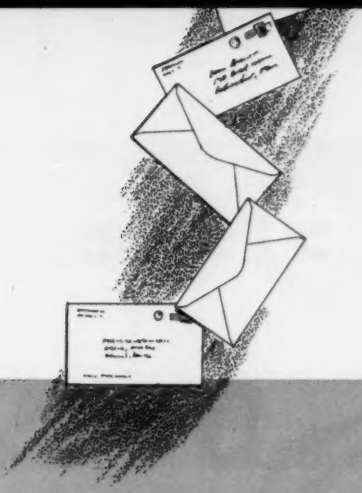




Vacuum Box Spaces Mail for Stacker

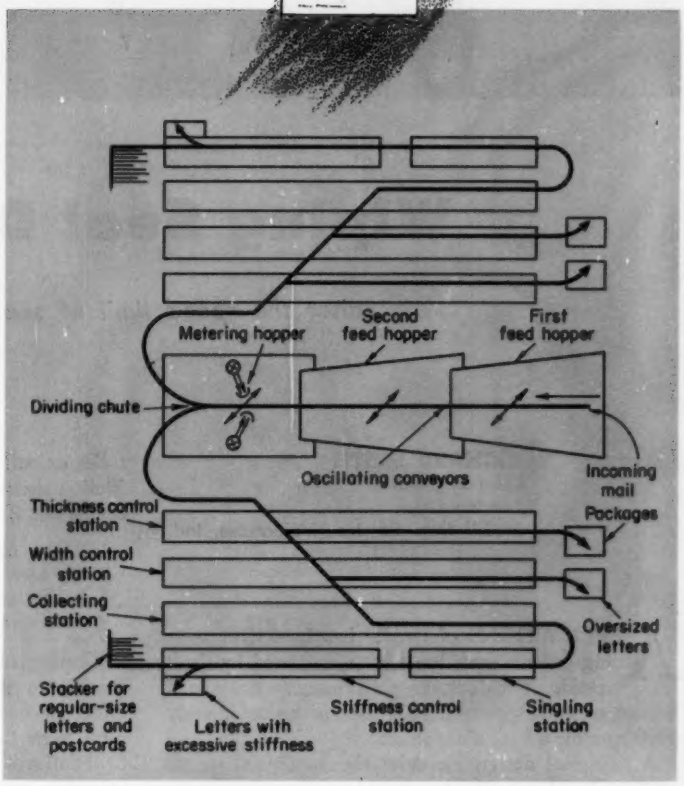
VACUUM STARTS A SINGLE LETTER on its way only when intermittent holes in the belt coincide with holes in the vacuum box. Spring clip holds remaining letters in place. Extra-stiff letters push over deflector spring to continue straight ahead into an accessory bin where they are picked out by hand. Normal letters are deflected to stacker where an attendant picks them out in stacks.

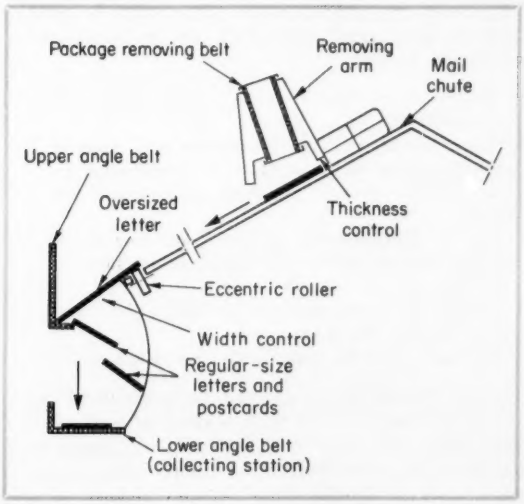




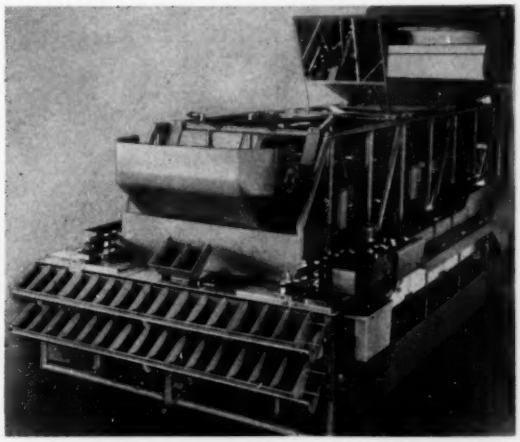
PROCESS STARTS with delivery of mixed mail to the first of three oscillating hoppers which shake the mail into a smooth flow of individual pieces equally divided between two identical sorting systems. A chute carries the mail across three diverting channels which separate out packages, oversize letters, and standard letters for the stacker.

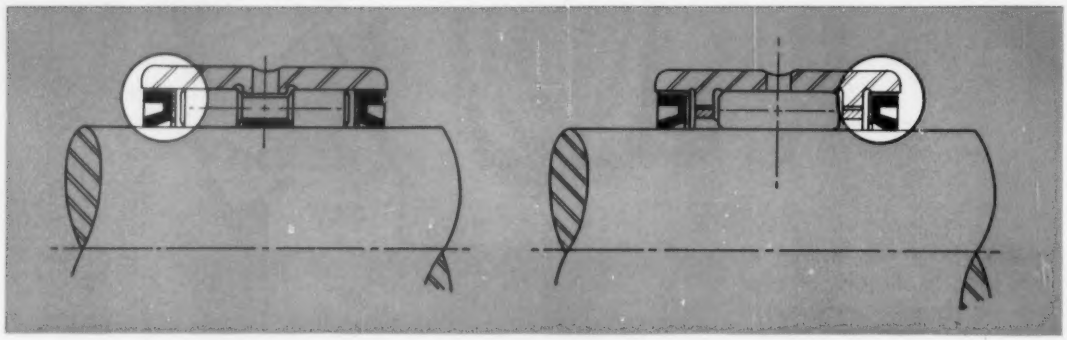
PACKAGE REMOVING BELT is equipped with arms that extend to within 0.4 in. from the mail chute. These rake packages thicker than 0.4 in. laterally off the chute. Letters move under the laterally moving arms to the chute's end where standard size letters drop between chute and upper angle belt that traps oversize letters and shunts them off.





Sorting and stacking machine, designed by Standard Electrik Lorenz, Berlin, Germany, uses oscillating hoppers and cross-flow conveyors to sort and regulate the flow of mail to the vacuum-box feed of the stacking mechanism.





Wiping Seal Design

. . . raises the speed limit of sealed bearings.

RICHARD SMITH
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APPLICATIONS of needle bearings with wiping contact seals have been restricted by shaft speed. Satisfactory performance has been limited to shaft speeds of 1000 fpm, or approximately 4000 rpm for a 1 in. diam shaft.

A new seal design increases the maximum speeds of these bearings. The result is a seal which permits shaft speeds as high as 3000 fpm, or 12,000 rpm for a 1 in. diam shaft.

Lubricating efficiency and operating temperatures tend to be more critical in needle bearings than in roller or ball bearings. Temperature rises due to seal friction should be held as low as possible. This condition is met if a seal has correct:

1. Rubber compound.
2. Lip hardness.
3. Lip design.
4. Seal-tolerance control.

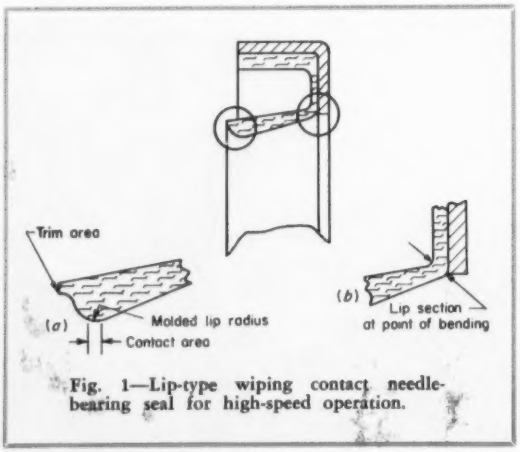


Fig. 1—Lip-type wiping contact needle-bearing seal for high-speed operation.

Temperatures over 225 F generally are detrimental to the life of seals because of the curing effect of heat on synthetic rubber. These rubbers tend to harden, or cure, if held at such temperatures. Seal failures occur as the lip embrittles. High-speed seal durometer hardness should be in the range of 80 to 90 for best performance. Lip design is most critical in high-speed seals. Five design considerations should be met:

1. Lip area at the point of contact should be as small as possible, Fig. 1*a*.
2. Contact diameter should be uniform and under as light a tension as consistent with contamination resistance and tolerance limitations of both seal and shaft.
3. The lip juncture with the metal seal case should be as thin as possible for minimum resistance to bending, Fig. 1*b*.
4. Diameter at contact should be molded to size, rather than trimmed, Fig. 1*a*.
5. Lip runout with the shaft should be a minimum.

If these considerations are met, temperatures from 175 to 200 F can be held with bonded or unbonded wiping seals and provide a successful resistance to grease leakage. Most Buna-N synthetic rubber compounds operate satisfactorily. Where leakage is a problem, grease dams can be molded on the interior portion of the lip. These divert the lubricant from the lip contact and prevent excessive leakage.

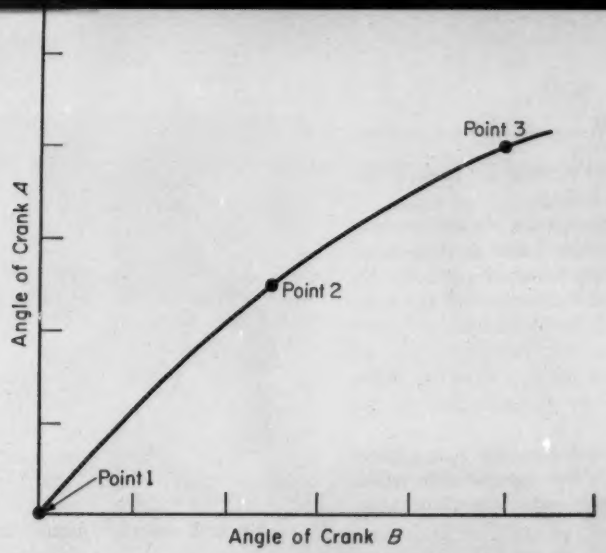
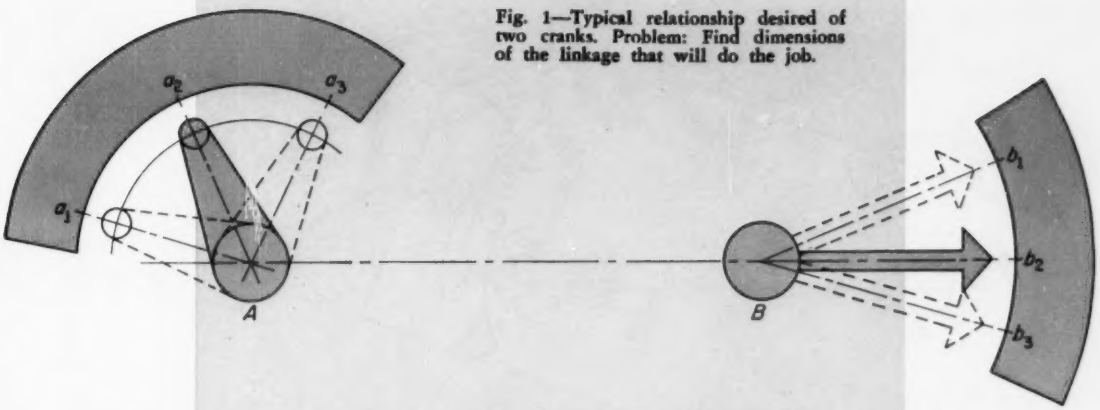


Fig. 1—Typical relationship desired of two cranks. Problem: Find dimensions of the linkage that will do the job.



Graphic Linkage Design

. . . a step-by-step procedure for satisfying input-to-output motion specifications at three positions. It works for both 2-D and 3-D linkages.

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A LINKAGE is an attractive solution to the problem of transforming motion. Apply the input motion to one crank of a four-bar linkage and get the desired output motion at the other crank.

But, the problem is how to proportion the linkage so that it produces the desired input-output rela-

tionship. Here is a graphical method for finding the dimensions required for the linkage.

The curve in Fig. 1 represents a desired motion relationship between bellcranks *A* and *B*. Any three points on this curve can be matched perfectly by this method. But the motion developed will not necessarily follow the required curve between adjacent points. However, changing the index position of crank *A* and its length, and making repeated trials, will generally lead to a close approximation of the desired curve.

Two methods are described here for a graphical solution to this problem: One for parallel crank axes and the other for skewed axes. For either case,

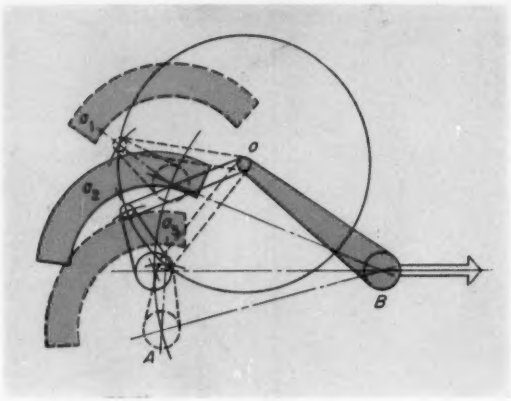


Fig. 2—Concept of rotating crank *A* about crank *B*.

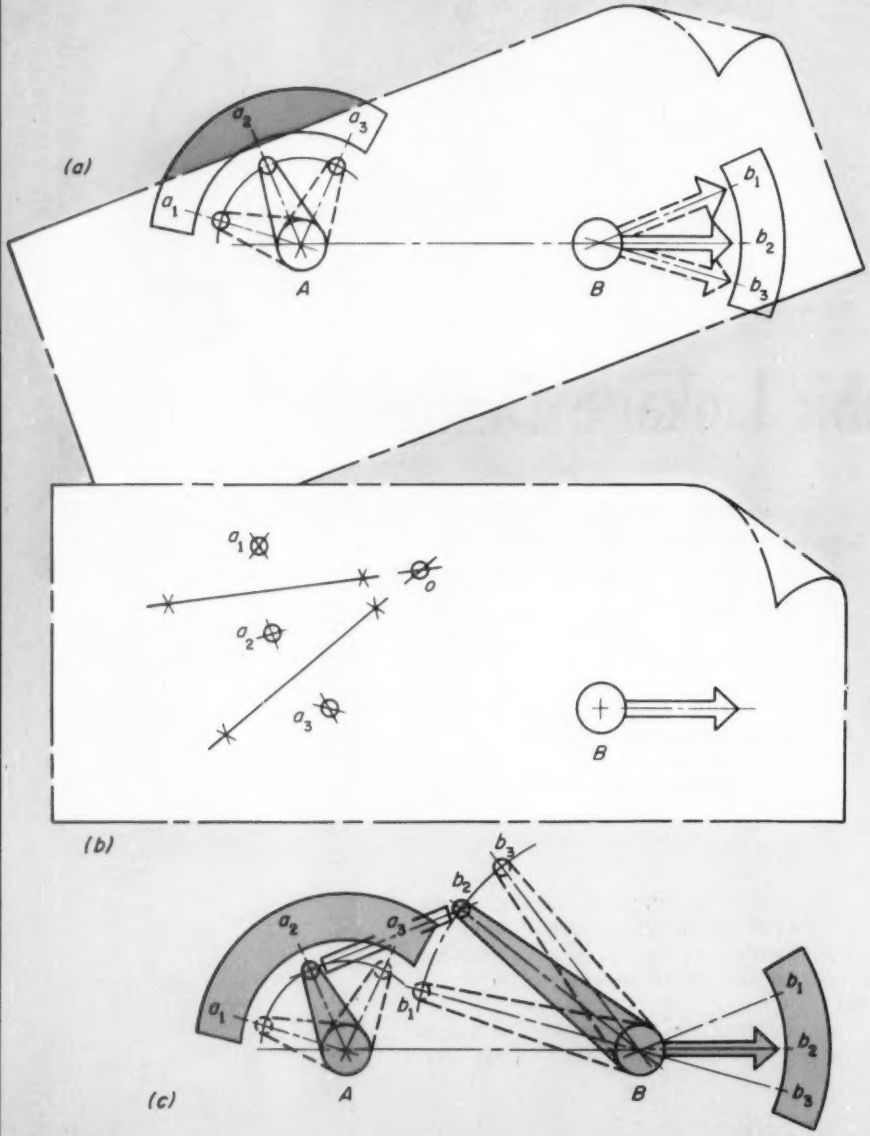
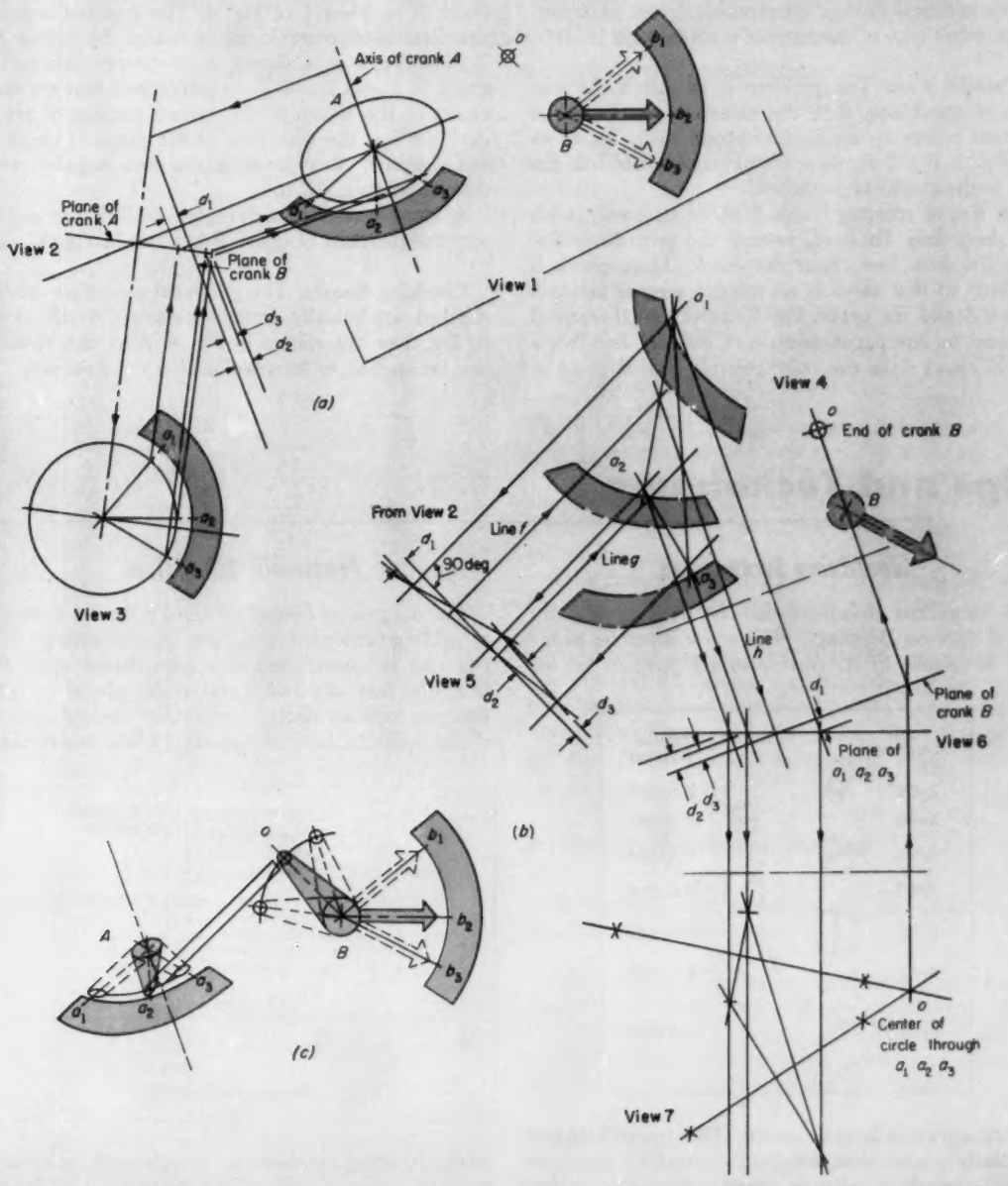


Fig. 3—Procedure for determining proportions of parallel-axes linkage.

1. Lay out the geometry of crank arm *A*, points a_1, a_2, a_3, and locate point *B* (*a*). Lay out the angles defined by points b_1, b_2, b_3 of crank arm *B*. This can be done anywhere about the pivot of crank arm *B* (*a*).
2. Using an overlay sheet and indexing it at position b_1, pick up point a_1 on crank *A*. Rotate the overlay about crank arm *B*, index at b_2 and b_3, and pick up the corresponding points of a_2 and a_3 (*a*). The overlay points are in phantom.
3. From three points a_1, a_2, a_3 on the overlay, swing arcs to find the center of the circle (point *o*) that is defined by these three points (*b*).
4. Index the overlay at b_2, to connect crank *A* at a_2, through the push rod to crank *B*. The other points are connected similarly (*c*).

Fig. 4—Procedure for determining proportions of skewed-axes linkage.

1. As in the parallel-axes case, use an overlay sheet. Rotate the overlay about the axis of crank *B*. Index at b_1, b_2, b_3, picking up points a_1, a_2, a_3, View 4.
2. Project View 5 in any convenient direction from View 4. This projection is used for the second view location of points a_1, a_2, a_3, and to determine the direction of projection of View 6 from View 4. In addition to the three points in View 5, draw a line, *h*, through two of the lines (*f*,*g*), defining the plane parallel to, or coincident with, the plane of crank *B*. Line *h* is the intersection of the plane of crank *B* and the plane of points a_1, a_2, a_3.
3. Project View 6 so that both the plane of a_1, a_2, a_3 and the plane of crank *B* are perpendicular to the plane of the paper.
4. Project View 7 so that points a_1, a_2, a_3 are now in the plane of the paper and form a circle with a center at *o* which can be found, as before, by graphical methods. This is a chord plane through a sphere. The center of that sphere will be on a line perpendicular to the plane of a_1, a_2, a_3 and passing through point *o*.
5. Project the perpendicular line through point *o* from View 7 into View 6. Where this line intersects the plane of crank *B* is the center of the sphere.
6. This point then projected into View 4 is now the end point of crank *B*. Transferred to the original layout (*c*), it completes the linkage.



it is necessary that certain information be completely defined (Fig. 1):

1. Radius and angular positions of one crank arm defined by three points.
2. Corresponding angles of the other crank.
3. Distance between crank axes.

Although this method provides a geometric solution, it is not necessarily a practical one. The resulting linkage must be examined for dead-center conditions, reversals, and mechanical advantage. If a solution is impractical, length or position of arm *A* should be changed and another trial made. Sometimes the angles being matched may be so related that a practical linkage is impossible. Then, of course, some other type of mechanism must be used.

Parallel Axes: The problem is to match the motion of crank arm *B* to the motion of crank arm *A* so that points a_1, a_2, a_3, correspond to b_1, b_2, b_3 as in Fig. 1. Fig. 2 shows a useful concept which is the key to the graphical procedure.

In lieu of rotating crank *B* about its center, with the base line *AB* fixed, reverse the procedure. Rotate the base line about the crank. Thus, crank *B* is fixed so that there is no relative motion between crank *B* and the paper. Fig. 2 shows that if crank *B* is fixed on the paper, point *a* of link *aB* describes a circle about *b* as the only possible loci of point *a*. Therefore, points a_1, a_2, a_3 must lie on this circle.

Conversely if points a_1, a_2, a_3 are defined, a circle can be drawn through the points, with its center at *o*.

The design procedure is detailed in Fig. 3.

Skewed Axes: The graphical solution for the skewed-axes case is similar. The major difference is that the end of the push rod travels on a sphere instead of a circle. This sphere can be determined by three points on its surface and a plane through its center. The three surface points are the known points in the motion of crank *A*. The central plane is the plane of motion of crank *B*. The layout process is similar to the first case, except that it is more complicated.

At the start the unknown crank-arm axis must be perpendicular to the plane of the paper. This is crank *B* in View 1 of Fig. 4. The required angular positions of this crank are indicated by points b_1, b_2, b_3. Crank *A* is shown in its proper relation to crank *B*. Views 2 and 3 are projections that are necessary in the layout of the correct position of crank *A*. View 3 is the *true* view of the plane of crank *A* and the only view to show the true angular positions of points a_1, a_2, a_3.

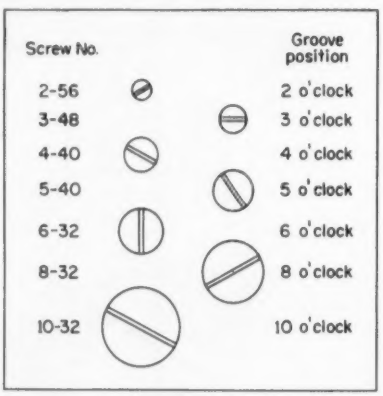
A step-by-step procedure for finding the radius and the positions of crank *B* is given in Fig. 4.

Checking Results: The graphical procedure can be checked analytically from equations for the circle in Fig. 3 or the sphere in Fig. 4. Also, this method can be applied to improve accuracy if necessary.

Tips and Techniques

Identifying Screw Sizes

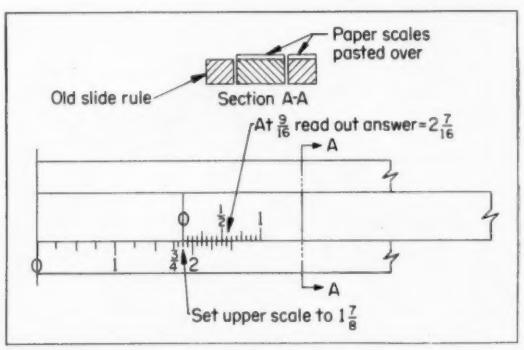
A simplified technique can be used to identify screw sizes on drawings. The screw diameter number is related to its corresponding position on an



imaginary clock face, as shown. Differences between similarly placed slots are distinguished by apparent head size.—E. L. KULIK, *design draftsman, Minneapolis Honeywell Regulator Co., Philadelphia.*

Fractional Slide Rule

The designer is frequently faced with the necessity of adding awkward fractions. A timesaving slide rule can be constructed as shown, based upon the principle that any two linear scales placed in conjunction form an adding device. Any desired division of the inch can be used including 64ths and decimal



parts. Reading convenience is increased by enlarging the over-all size of the ruler.—G. F. PELTZ, *Aerojet General Corp., Sacramento, Calif.*

Stress and Deflection in Shafts

Handbook formulas for beams are no help when a shaft has three or more supports. The beam is continuous or indeterminate. Two easy techniques are outlined here for such situations:

1. The moment-distribution method for finding stresses.
2. A graphical-integration method for finding deflections.

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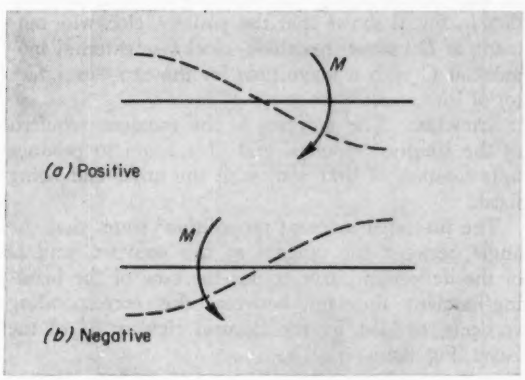


Fig. 1—Convention for external moments.

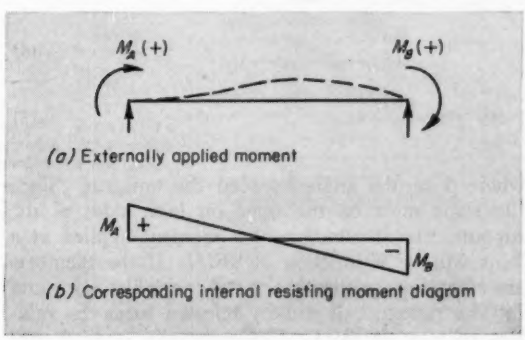


Fig. 2—Comparison of moment conventions.

MOMENTS and deflections of beams can be determined by many methods. Some are relatively complicated procedures; others, more simple, are applicable only to specific problems involving, for example, equal spans with symmetrically placed loads.

Two methods, used frequently by aeronautical and structural engineers, are worthy of wider use because they are easy to apply to continuous spans with complex loading. One is the moment-distribution method for calculating moments and the other is a graphical-integration method for determining deflections. These methods give a clear concept of the true physical action involved in beam analysis.

Moment-Distribution Method

Assumptions, sign conventions, and basic terms should first be agreed upon.

Assumptions: All basic assumptions of elastic beam theory shall hold. Supports are nonsettling with horizontal deflections prevented. Also, moment of inertia shall be constant for a given span, but not necessarily constant throughout the beam.

Sign Convention: Beams may be analyzed by study of the externally applied moments or the internal resisting moments. A sign convention[1] for

[1]References are tabulated at end of article.

each method follows:

EXTERNAL MOMENT: The sign of the end moment in a member is taken as positive if the end moment tends to rotate the joint in a clockwise direction, Fig. 1. This convention is generally more convenient and will be used later in an example.

INTERNAL RESISTING MOMENT: A moment is taken as positive when it produces tension in the bottom fibers. This method is the same as normally used in the study of strength of materials. A comparison of the two methods is displayed in Fig. 2.

Definitions: Several terms warrant explanation or clarification. They are:

CARRY-OVER FACTOR: Ratio of the moment at the fixed end of a beam to the moment producing rotation at the propped end is the definition of the carry-over factor. To establish a definite value for this factor, examine the action that actually takes place in the moment-distribution method, Fig. 3. A span CD is restrained at C and a clockwise moment applied at D, Fig. 3*a*. To determine the moment induced at C by the applied moment at D, first plot the internal-moment diagram by parts for the beam, Fig. 3*b*. The relationship between the moments at C and D can be determined from the second "area-moment" proposition.[2] It states that if C and D are points on a deflection curve, the vertical distance of D from the tangent drawn to the curve at C is equal to the moment with respect to the vertical through D of the area of the bending-moment diagram between C and D, divided by the flexural rigidity EI:

$$\Delta_D = 0 = \frac{R_D L^2}{2}\,\frac{2L}{3} - \frac{M_D L^2}{2} \tag{1}$$

$$R_D = \frac{3M_D}{2L} \tag{2}$$

where Δ_D = vertical deflection of point D, and R_D = reaction at point D. The resulting moment at C caused by applied moment M at D is

$$M_C = \frac{3M_D L}{2L} - M_D$$

$$= \frac{M_D}{2} \tag{3}$$

which results in the final internal-moment diagram of Fig. 3c. Applying the external-moment convention in Fig. 2 shows that the positive, clockwise moment at D causes a positive, clockwise external moment at C with a magnitude for the carry-over factor of $\frac{1}{2}$.

STIFFNESS: The stiffness is the moment required at the simply supported end of a beam to produce unit rotation of that end, with the other end being fixed.

The first area-moment proposition[2] states that the angle between the tangent at two points C and D of the deflection curve equals the area of the bending-moment diagram between the corresponding verticals, divided by the flexural rigidity EI of the beam, Fig. 3c:

$$\theta_{D-C} = -\frac{M_D L}{3EI} + \frac{M_D L}{12EI}$$

$$= -\frac{M_D L}{4EI} \tag{4}$$

$$M_D = -\frac{4EI}{L}\,\theta_{D-C} \tag{5}$$

where θ = the angle between the tangents. Since the slope must be the same on both sides of the support, the distribution of a moment applied at a joint will be a function of $4EI/L$. If the members are of uniform material, the only variables are I and L. The ratio I/L is usually referred to as the *relative stiffness factor* K. The externally applied moment must be distributed in proportion to the rela-

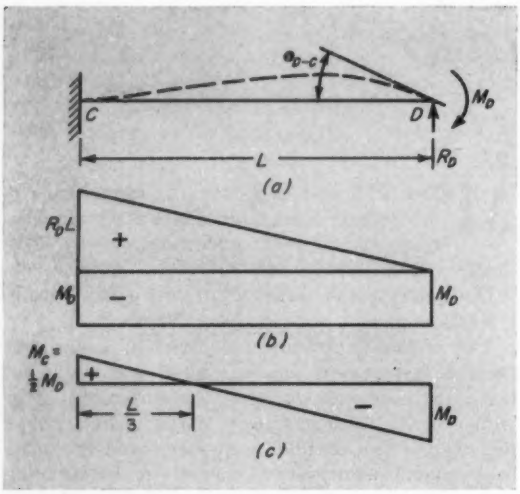


Fig. 3—Essentials of the moment-distribution method.

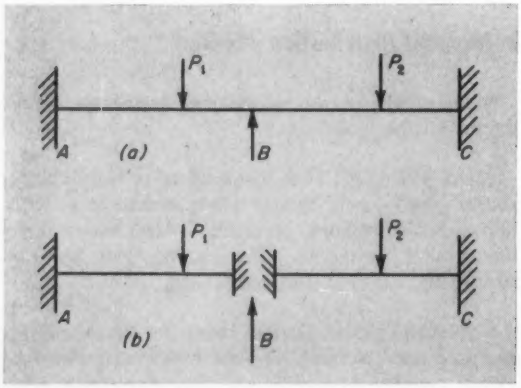
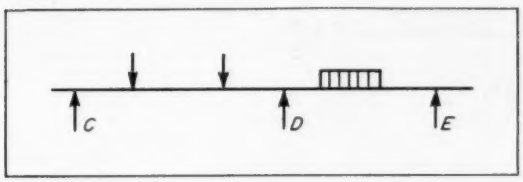


Fig. 4—How a beam is "separated" to simplify analysis.

tive stiffnesses of the joining spans. The *distribution factor*, therefore, is equal to $K/\Sigma K$.

As an example, a two-span beam with external loading P_1 and P_2 is shown in Fig. 4*a*. To analyze this beam by moment-distribution, fix the center support (restrain it against rotation) so that the beam is as shown in Fig. 4*b*. If the loads are not equal or symmetrically placed, the moment to the left of B caused by load P_1 will not be the same as the moment to the right of B caused by P_2. An unbalance will exist in the restrained beam. This situation cannot exist in the real beam and still satisfy the conditions for equilibrium. That is, the sum of the end moments which any joint exerts on the ends of members meeting there must be zero. To satisfy this condition, apply an external moment equal in magnitude and opposite in direction to the unbalance. This moment will be distributed at the joint according to the relative stiffnesses at the joint, and a proportionate amount of this distributed moment must then be "carried over" to the opposite end of the span.

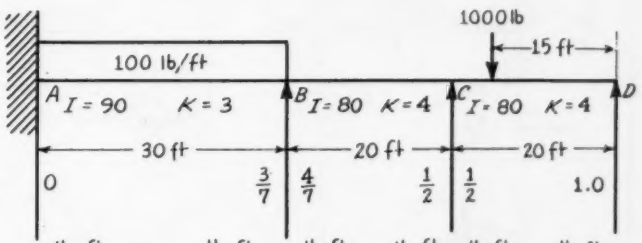


In a continuous beam of two or more spans, with the ends simply supported, this procedure of balancing and then relocking would be applied at all joints. It is obvious that balanced joints are continuously unbalanced by carry over effects of adjacent spans and must be rebalanced. This process should be repeated for a sufficient number of cycles until the unbalance of these carry-over effects are small enough to be neglected.

The process of moment distribution begins with relative stiffnesses and fixed end moments, and terminates with final moments. Since there exists the possibility of error in arriving at the final end moments, the calculations should be checked.

An obvious check from the conditions of statics

Fig. 5—Example showing how Equations 6 and 7 are set up.



	lb-ft	lb-ft	lb-ft	lb-ft	lb-ft	lb-ft
Fixed-end moments ÷ 10	+750	-750	0	0	+280	-94
First distribution	0	+322	+428	-140	-140	+94
Carry-over moments	+161	0	-70	+214	+47	-70
Second distribution	0	+30	+40	-130	-130	+70
Carry-over moments	+15	0	-65	+20	+35	-65
Third distribution	0	+28	+37	-27	-28	+65
Carry-over moments	+14	0	-14	+19	+33	-14
Fourth distribution	0	+6	+8	-26	-26	+14
Carry-over moments	+3	0	-13	+4	+7	-13
Fifth distribution	0	+6	+7	-6	-5	+13
Carry-over moments	+3	0	-3	+4	+7	-3
Sixth distribution	0	+1	+2	-6	-5	+3
Total	+946	-357	+356	-74	+75	0
Actual moments	+9460	-3560	+3560	-750	+750	0
Check:						
Change at near end	+196	+393	+356	-74	-205	+94
-½ change at far end	-196	-98	+37	-178	-47	+102
Sum	0	+295	+393	-252	-252	+196
Sum ÷ (-K)	0	-98.3	-98.2	+63	+63	-49

Fig. 6 — Example problem for moment-distribution method.

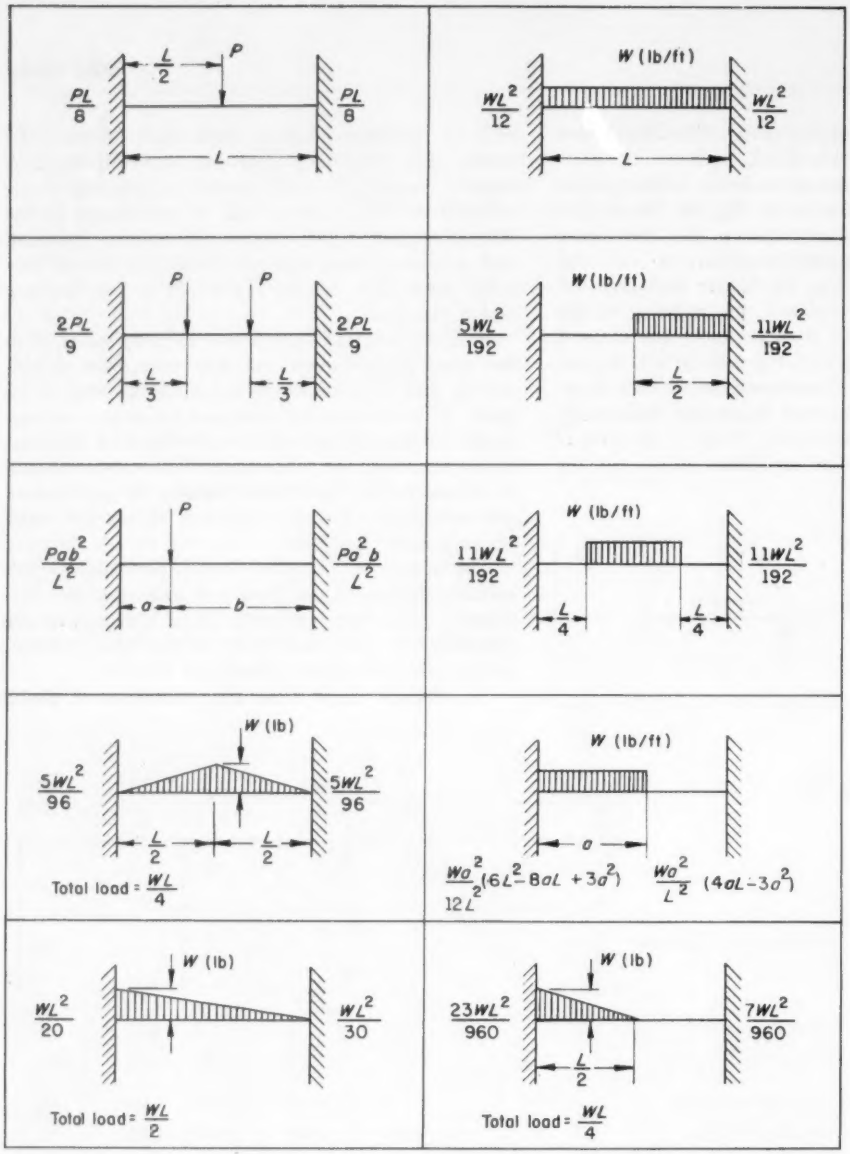


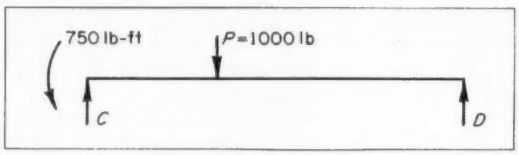
Fig. 7—Fixed-end moments for constant-section beams.

Fig. 8—Free-body diagram of portion of beam for step 7 of moment - distribution procedure.

is to see if the moments are balanced at each interior support and if the moment is zero at any exterior simple support. However, there still remains a check on the continuity of the structure. This check will indicate whether the rotations at opposite sides of a support are equal and whether the rotation at a fixed support is zero. The end rotations can be expressed in terms of the initial fixed-end moments and the final end moments.[3] Then, the relative value of the end rotation is equal to the change in the moments at the near end minus one-half of the change in the far end, all divided by $-K$. For any two spans, such as CDE in Fig. 5, relative rotations are

$$(\theta_{D-\tau})_{rel} = \frac{\Delta M_{DL} - \frac{\Delta M_{CR}}{2}}{(-K)_{C-D}} \quad (6)$$

$$(\theta_{D-E})_{rel} = \frac{\Delta M_{DR} - \frac{\Delta M_{EL}}{2}}{(-K)_{D-E}} \quad (7)$$



where ΔM is the final moment minus the initial fixed-end moment, and subscripts L and R refer to the left and right-hand sides of the joint.

Moment-Distribution Example: A continuous beam with varying moments of inertia will be investigated. The loaded beam and the tabulated solution for moments are shown in Fig. 6. The recommended procedure is:

STEP 1. Determine the relative stiffness of each span, $K = I/L$. Often, it will be advantageous to use relative values of the moment of inertia instead of

the actual numerical values.

STEP 2. Solve for the distribution factors at each joint, ($DF = K/\Sigma K$). At joint A, the fixed support, the distribution factor is zero since it can resist any moment assigned to it and need not be released. At joint D the distribution factor is 1.0 since $\Sigma K = K$.

STEP 3. Determine the fixed-end moments using the sign convention discussed for externally applied moments. Formulas are given in Fig. 7.

STEP 4. Release the joints one at a time and balance the moments. Since joint A has no artificial restraint, it cannot be released and balancing is not necessary. At joint B the unbalance is -750 lb-ft; an exterior moment of $+750$ lb-ft must be applied at the joint. This moment is distributed according to the relative stiffnesses; that is, $+322$ to the left of joint B and $+428$ to the right of the joint. Since for a propped cantilever the carry over to the fixed end is one-half of the applied moment, carry over moments of $+161$ and $+214$ as shown. Joint B is now restrained again, and the same procedure is followed for the other joints. Due to the carry-over effect,

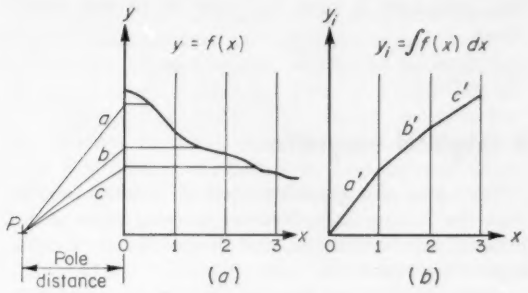


Fig. 9 — Graphical-integration method in general terms.

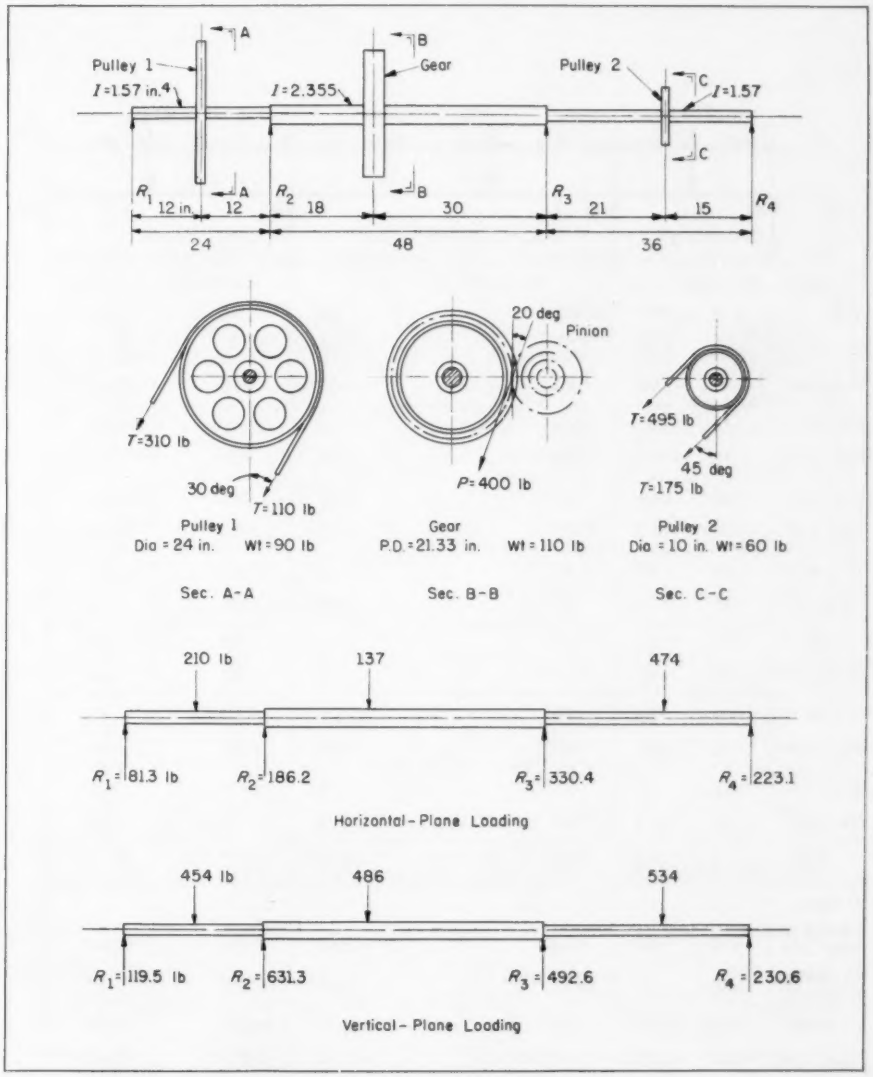


Fig. 10—Loading conditions for example problem.

unbalance again exists, and the procedure is repeated for all joints.

STEP 5. Sum the moments and check to see if the moments at the joints are balanced and if the moment at an exterior simple support is zero.

STEP 6. Check for continuity.

STEP 7. From the moments, calculate reactions and shears and analyze as in any determinate problem. A simple approach in finding the reactions is to take out span *CD* as a free body, Fig. 8:

$$\Sigma M_C = 0$$

Therefore,

$$-750 \text{ lb-ft} - 20 R_D + (5 \text{ ft})(1000 \text{ lb}) = 0$$

and

$$R_D = 212.5 \text{ lb}$$

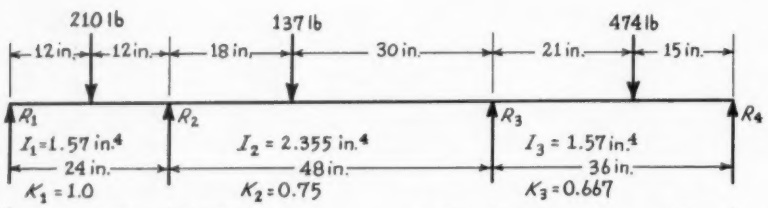
Similarly, $R_C = 647$ lb, $R_B = 1443.8$ lb, and $R_A = 1696.7$ lb.

Overhanging Loads: Another condition which is occasionally encountered is the analysis of a continuous beam having an overhanging end span. Since the end of the beam is free to deflect in either direction, the stiffness of that span is equal to zero, and the distribution factor is also equal to zero. The procedure is then the same as in any other beam.

Graphical Integration

The value of a graphical method of integration is that the mathematics becomes nothing more complicated than arithmetic, and the possibility of error is greatly reduced.

Geometrically, an integral is the area under a curve between definite limits. The function that is to be integrated must be plotted for the range of values known before the graphical method can ac-



D. F.	1.0	0.572	0.428	0.53	0.47	1.0
	lb-in.	lb-in.	lb-in.	lb-in.	lb-in.	lb-in.
F. E. M.	+630	-630	+963	-578	+1728	-2419
No. 1 dist	-630	-190	-143	-609	-541	+2419
C. O. M.	-95	-315	-305	-72	+1210	-271
No. 2 dist	+95	+355	+265	-603	-535	+271
C. O. M.	+178	+48	-302	+133	+136	-268
No. 3 dist	-178	+145	+109	-143	-126	+268
C. O. M.	+73	-89	-72	+55	+134	-63
No. 4 dist	-73	+92	+69	-100	-89	+63
C. O. M.	+46	-37	-50	+35	+32	-45
No. 5 dist	-46	+50	+37	-36	-31	+45
C. O. M.	+25	-23	-18	+19	+23	-16
No. 6 dist	-25	+23	+18	-22	-20	+16
C. O. M.	+12	-13	-11	+9	+8	-10
No. 7 dist	-12	+14	+10	-9	-8	+10
Total	0	-570	+570	-1921	+1921	0
Check:						
Change at near end	-630	+60	-393	-1343	+193	+2419
-½ change at far end	-30	+315	+672	+197	-1210	-97
Sum	-660	+375	+279	-1146	-1017	+2322
Sum÷(-K)	+660	-375	-372	+1528	+1526	-3483

Fig. 11—Moment distribution for horizontal plane.

tually be applied. The method proposed for beam analysis is first demonstrated here by a simple example in general terms, $y = f(x)$.

As in Fig. 9*a*, plot the general function to some convenient scale. Divide the x axis into equal increments, as indicated by the vertical lines. Since the choice of the x increment governs how closely the graphical solution will approximate the analytical solution, these divisions should be as small as possible. Locate a reference point P to the left of the diagram, and project the average ordinate for each interval to the y axis. Then, draw lines from point P to these projected points. The slopes of these lines (a, b, and c) vary directly as the area under the curve for the corresponding interval. The ratio of the slopes obviously does not depend on the location of the reference point, often referred to as the *pole point*. To construct the integrated function, Fig. 9*b*, draw line a' parallel to line a from Fig. 9*a*, and lines b' and c' parallel to b and c.

If the pole point had been located twice as far away from the y axis, the resulting curve would have been compressed in the vertical direction to one-half the size shown. This fact suggests that a relationship exists between the location of the point, the scales used in plotting the original function, and the scale of the integrated function. The relationship is

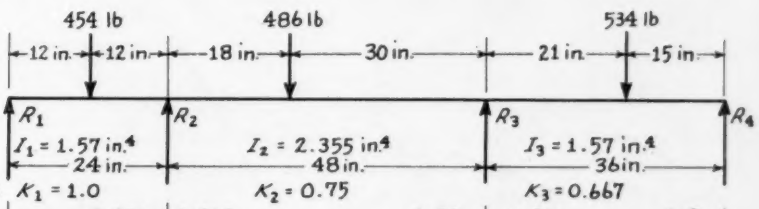
$$S_{yi} = S_y S_x \text{ (pole distance)}$$

where S_{yi} = scale of integrated function in the y direction, S_y = scale of original function in the y direction, and S_x = scale of original function in the x direction.

Care must be exercised in plotting the original function, in transferring the parallel lines from the pole point, and in evaluating integrated function.

A Practical Example

A continuous shaft of varying cross section is loaded as shown in Fig. 10. The problem is to find



D.F.	1.0	0.572	0.428	0.53	0.47	1.0
	lb-in.	lb-in.	lb-in.	lb-in.	lb-in.	lb-in.
F.E.M.	+1362	-1362	+3417	-2050	+1947	-2726
No.1 dist	-1362	-1175	-880	+55	+48	+2726
C.O.M.	-588	-681	+28	-440	+1363	+24
No.2 dist	+588	+374	+279	-489	-434	-24
C.O.M.	+187	+294	-245	+140	-12	-217
No.3 dist	-187	-28	-21	-68	-60	+217
C.O.M.	-14	-94	-34	-11	+109	-30
No.4 dist	+14	+73	+55	-52	-46	+30
C.O.M.	+37	+7	-26	+28	+15	-23
No.5 dist	-37	+11	+8	-23	-20	+23
C.O.M.	+6	-19	-12	+4	+12	-10
No.6 dist	-6	+18	+13	-8	-8	+10
C.O.M.	+9	-3	-4	+7	+5	-4
No.7 dist	-9	+4	+3	-6	-6	+4
Total	0	-2581	+2581	-2913	+2913	0
Check:						
Change at near end	-1362	-1219	-836	-863	+966	+2726
-½ change at far end	+610	+681	+432	+418	-1363	-483
Sum	-752	-538	-404	-445	-397	+2243
Sum÷(-K)	+752	+538	+538	+593	+595	-3363

Fig. 12—Moment distribution for vertical plane.

the maximum stresses and the path of the elastic curve.

Sections *A-A*, *B-B*, and *C-C* reveal that this problem involves loads applied in several planes. Simplify this condition by resolving the loads into their vertical and horizontal components by the usual methods of statics, Fig. 10. The shaft can now be analyzed for each plane and the results combined by superposition.

Since the reactions cannot be found until the moments are determined, apply the moment-distribution method, Fig. 11 and 12, and check the results. From the moments, find the reactions using the basic conditions of statics. Now, it is possible to draw the shear, the moment, and the *M/EI* diagram, Fig. 13, 14, and 15. The sudden changes in the moment of inertia cause abrupt changes in the *M/EI* diagram but do not noticeably affect the other diagrams. The *M/EI* curve must be integrated twice to obtain the deflection curve. For this work, graphical integration gives results quickly and easily. In both Fig. 14 and 15, take points every 3 in. of shaft length, as indicated by the grid lines shown in the figures. In Fig. 14 the slopes for the first three points are labeled in the *M/EI* diagram and shown in the slope diagram.

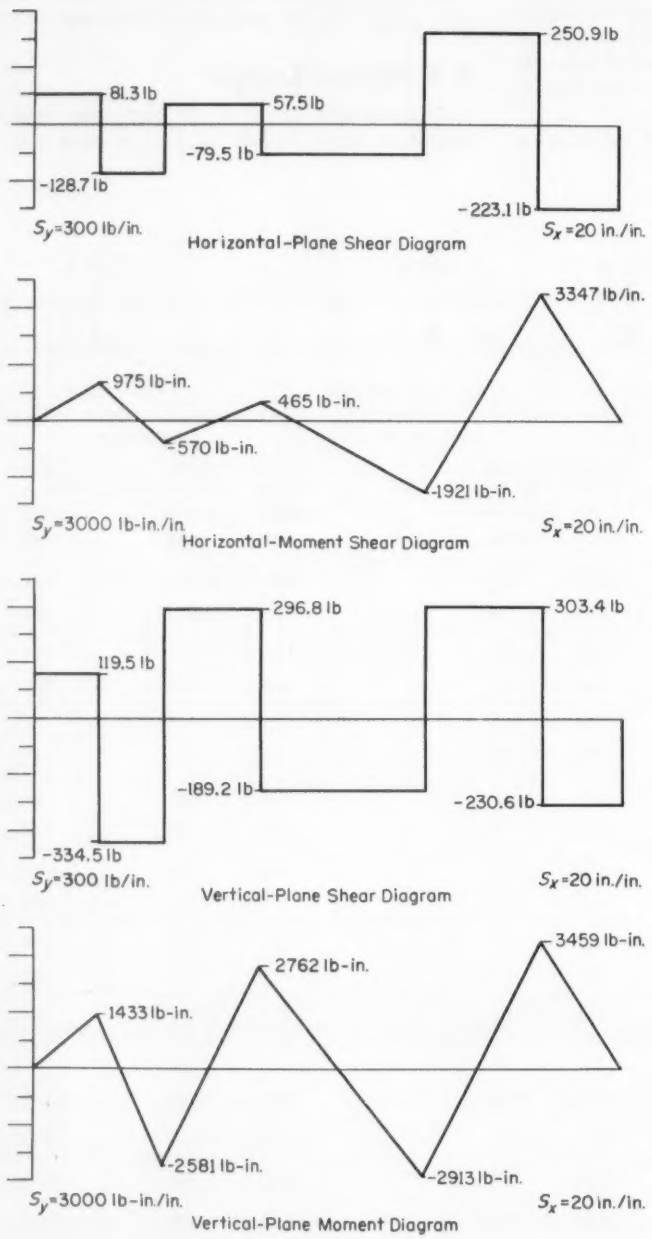


Fig. 13 — Shear and moment diagrams.

To integrate the slope diagram, choose a point in each span where the slope of the deflection curve is assumed to be zero. Through these three points, draw horizontal lines to establish the pole point for integration. Then, integrate, span-by-span. After developing the deflection curve, draw a straight line connecting the points on the curve corresponding to the support points. Since these lines are not horizontal, a corrected deflection curve must be drawn.

Draw a horizontal line and lay off the *vertical* distance from the deflection curve to the straight line. Through all of these points, draw a smooth curve. It is the elastic curve for the beam in that particular plane.

To find the actual deflection of the shaft at pulley 2 (station 8) resolve the deflections in the horizontal and vertical planes. The maximum deflection, occurring at pulley 2, is 84.8 × 10^{-4} in. in a plane approximately 43.5 deg to the horizontal plane.

The two deflection curves show that the actual elastic curve for the shaft takes the form of a helical curve. The actual magnitude of the deflection at any point in the shaft can be found by resolving the components in the vertical and horizontal plane.

Stresses can now be determined. For this example,

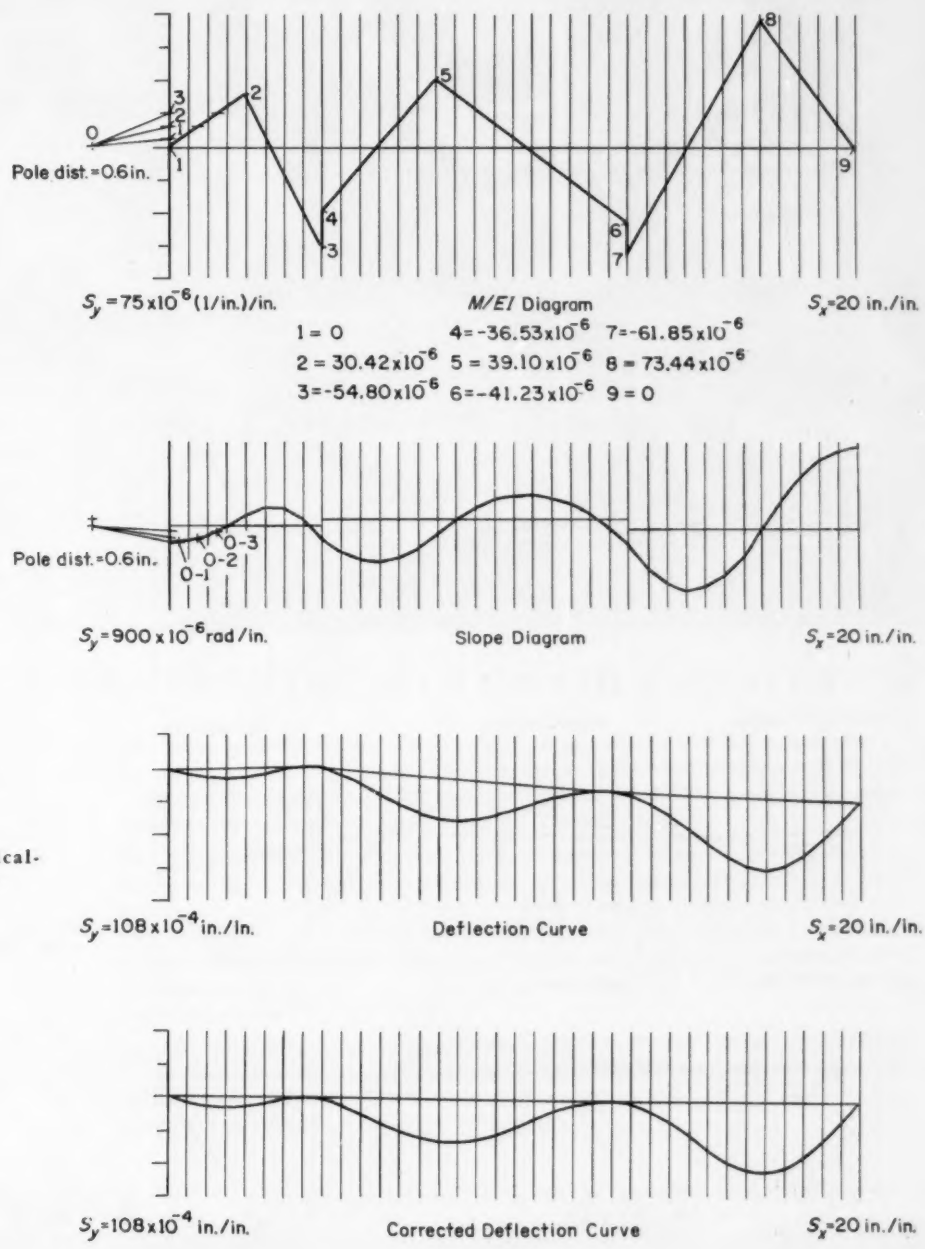


Fig. 14 — Vertical-plane deflection.

use the *ASME Code for the Design of Transmission Shafting*, B17c-1927 (for solid shafts neglecting axial loads). Maximum shearing stress is given by

$$\sigma = \frac{16}{\pi D^3}\left[(K_m M)^2 + (K_T T)^2\right]^{1/2}$$

where K_M = numerical combined shock and fatigue factor to be applied in every case to the computed bending moment, K_T = corresponding factor to be applied to the computed torque. M = bending moment (in this case, the resultant of the combined vertical and horizontal moments, $M = (M_V^2 + M_H^2)^{1/2}$, T = torque transmitted by shaft at point in question, and D = diameter of the solid shaft at the point in question.

With values of 2.50 for K_M and 2.25 for K_T, the stress at pulley 2 is 4753 psi. This value of stress is well within the allowable range for the presence of a keyway as suggested by the Code.

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2. S. Timoshenko and G. H. McCoullough—*Elements of Strength of Materials*, D. Van Nostrand Co. Inc., New York, 1949.
3. C. K. Wang—*Statically Indeterminate Structures*, McGraw-Hill Book Co. Inc., New York, 1953.

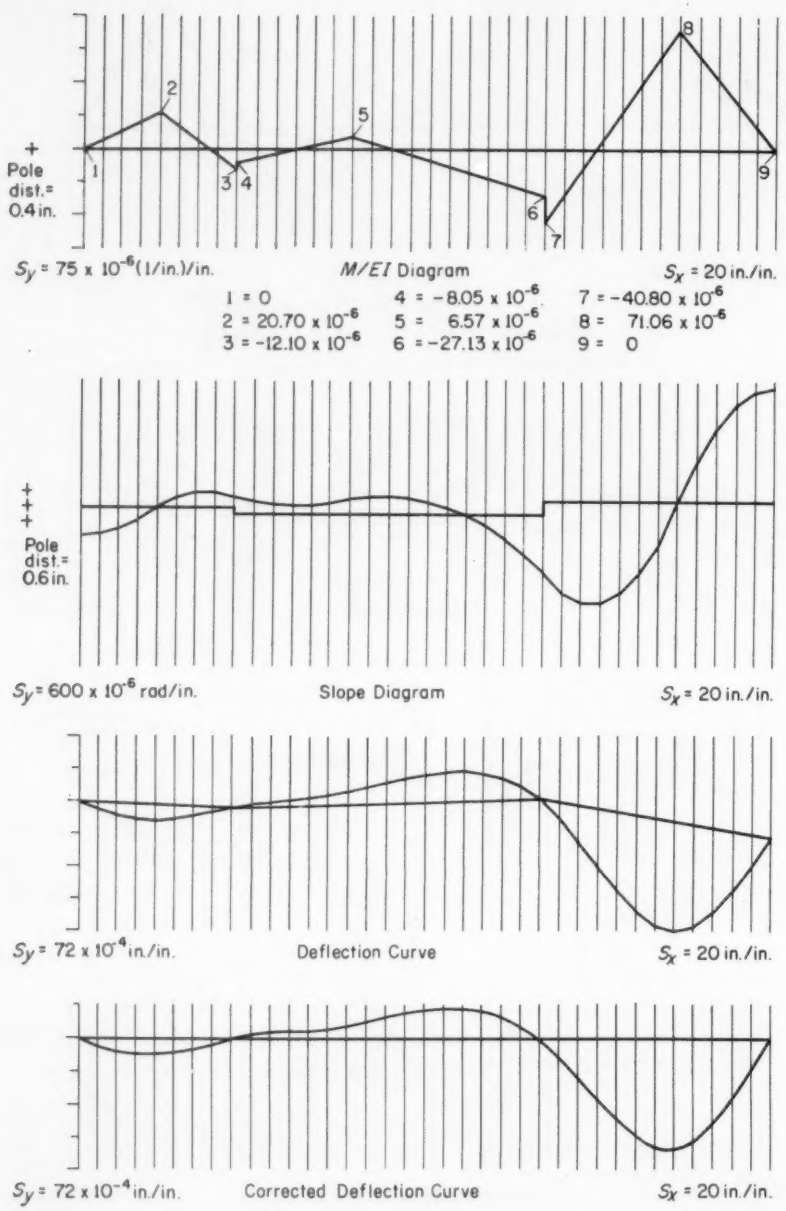

Fig. 15 — Horizontal-plane deflection.

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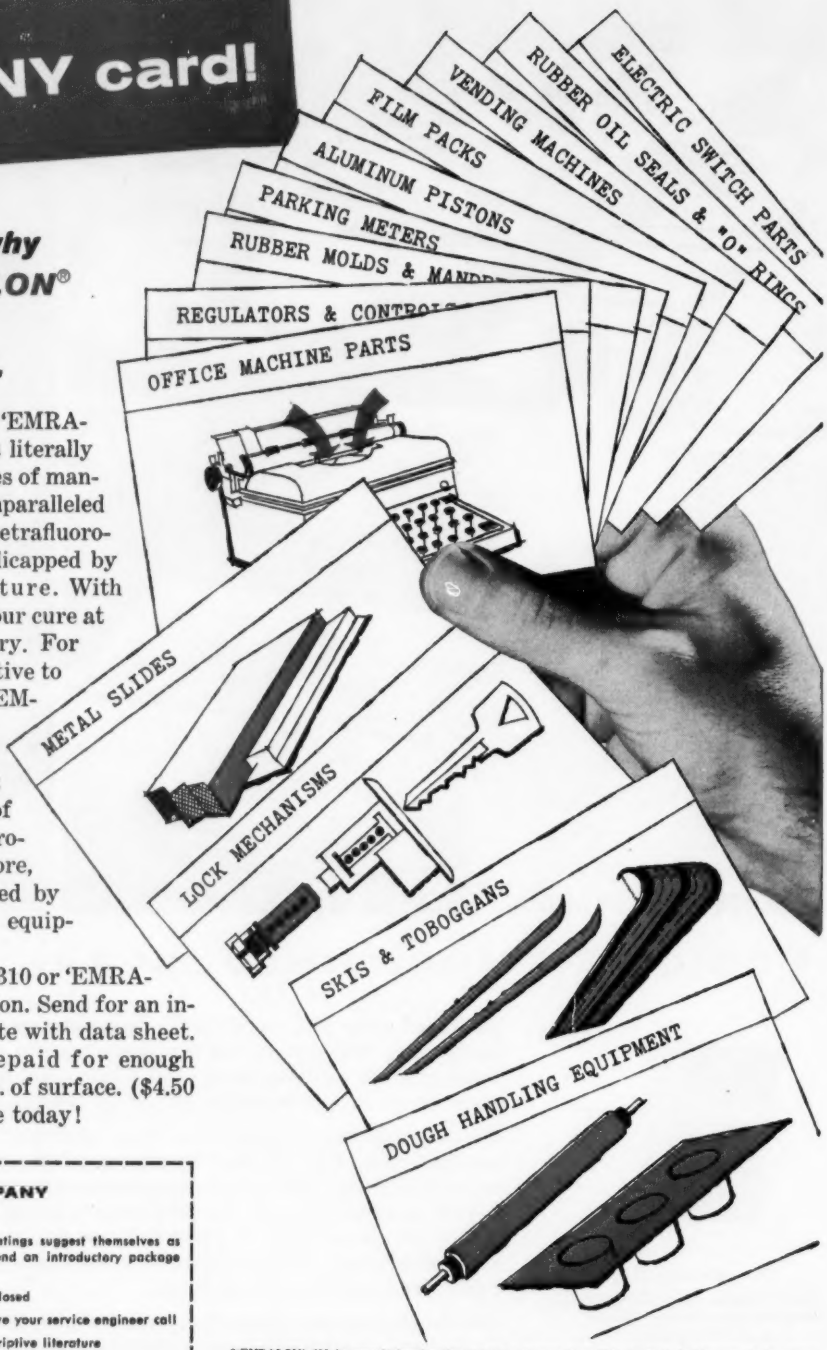

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How to get your money's worth in

Selecting Threaded Fasteners

FREDERICK E. GRAVES
Assistant Technical Director
Russell, Burdsall & Ward Bolt and Nut Co.
Port Chester, N. Y.

STANDARDIZATION of fasteners can result in optimum inventory and reduced cost of purchase. This paper explores major areas in which standards policy and practice prove profitable.

Thread Series: For a particular job, should a fine thread or a coarse thread be used? Either type is easy to produce, but the coarse thread has the advantage of being stronger, less subject to thread nicking in handling, and better adapted to subsequent plating or coating processes. In addition, coarse threads are affected to a considerably lesser degree by decarburization and corrosion. Fine-thread applications are limited. One application, for instance, is where the movement of the bolt performs some adjustment function.

Class of Fit: Class 2A fit for external threads and Class 2B for internal threads should be specified unless there is a special reason to use one of the other classes. Class 2A and 2B fits allow for manufacturing and plating tolerances and still provide a class of fit that enables the full strength of a bolted assembly to be developed without thread stripping. It also provides easy bolt and nut assembly in production.

No application requires the old Class 2 thread fit for unplated threads. Specifications often do read, however, that a fastener should be threaded to a Class 2A fit prior to plating, and meet Class 2 specifications after plating. One word of caution: An externally threaded Class 2 fastener, after plating, should be accepted by a Class 2 go gage, but the fastener should not be rejected if it will also go in a Class 2 no-go gage. The reason is that the plating will not build up evenly on both the flank and the crest of the thread. As long as the fastener assembles to its mating part, the fact that its pitch diameter is slightly below limits does not affect its use.

Class 3, 3A, and 4 thread fits should be specified only when the threaded member has to perform a function other than fastening, such as adjustment or positioning.

Six Ways to Save

1. Standardize on coarse threads to a Class 2A external fit or a Class 2B internal fit.
2. Use bolts or cap screws in place of stud and nut combinations.
3. Standardize on a maximum of three or four head styles for machine screws. Standardize on hex-head bolts rather than square head.
4. Specify bolt materials according to the physical properties necessary for functional requirements rather than chemical analysis.
5. Specify commercial zinc plating for applications where there is no unusual corrosion problem.
6. Consider standardizing on high-strength cap screws or bolts made from 1038 steel, heat treated to a tensile strength of 120,000 psi.

Bolts Versus Studs: The use of studs in tapped holes should be avoided in favor of a conventional bolt or cap screw in a hole tapped to a 2B class fit. Tests have shown that a bolt can be disassembled and reassembled in a hole tapped in cast iron at least 50 to 75 times without injuring the tapped thread.

Where the fastener to be used is less than 1 in. in diameter and does not exceed 6 in. in length, the use of a hex-head bolt or cap screw is less expensive in initial cost than the combination of a stud plus a nut. Another factor is the cost of producing interference-fit threads and the cost of setting studs.

Style of Head: Standardize on

a maximum of three or four head styles for machine screws and standardize on hex head bolts and hex nuts. Square head bolts offer no advantages over hex head bolts.

Material Specifications: The steel analyses most commonly used for bolting are: SAE 1010 for machine screws, carriage bolts, and similar products, applications for which inherent strength is not a critical factor. SAE 1018, 1020, and 1021, for bright cap screws and the general run of special items. SAE 1038 for high-strength or high-tensile cap screws and bolts.

In addition, most major bolt manufacturers maintain stocks of 1041, 1045, and either 1330 or 1340. Nut steels normally are the resulfurized 1100-series steels. Some nuts are also being made from 1016 and 1038, and a hot-formed nut from 1045.

Except where corrosion-resistant properties are important, specify bolt materials in accordance with the physical properties suited to the function rather than by chemical analysis.

Plating Specification: Both zinc plating and cadmium plating are normally controlled to approximately 0.00015 in. thickness. In most instances, this thickness is satisfactory for a fastener with a 2A-class thread. Plating thicknesses in excess of 0.0002 to 0.0003 in. increase manufacturing costs. Normal specifications for zinc coating is covered by ASTM designation A164-55, Type RS.

The usual accelerated test for determining the corrosion resistance of plating on steel is the so-called salt spray test. In this test, cadmium plating shows a far greater resistance to corrosion than does zinc. In typical industrial atmospheres, however, zinc plating resists corrosion for a longer period than cadmium. Wherever possible standardize on zinc plating of normal commercial thickness.

Strength of Material: Engineers can achieve cost savings in the use of threaded fasteners by investigating the selection of bolt diameters and bolting materials. In many cases, allowable bolt loads are greatly less than the actual working strength. The only factor of safety needed in maintaining a tight joint for a threaded fastener involves the amount of preloading exerted on the fastener.

The fundamental approach to the economical selection of fasteners is not how many nuts and bolts can be purchased for a dollar, but how many pounds of holding power can be purchased for a dollar. The heat-treated cap screw has a clamping strength at least 60 per cent greater than the ordinary bright cap screw and in practically every instance the next smaller size high-carbon cap screw can be used in place of the bright cap screw. This type of substitution results in a saving of approximately 25 per cent in fastener cost. This substitution should be considered for any new designs.

ASA paper, "Six Easy Ways to Save Money in Fasteners," presented at the Tenth National Conference on Standards of the American Standards Association, October, 1959, 11 pages.

electrical

Electronic Circuit Tolerances

K. S. Packard, M. Goldstein, N. Stone, and J. Cavallari, Airborne Instruments Lab., Cutler-Hammer Inc.

An aid to the circuit designer in development of new circuits. The design engineer can contribute significantly to reliability by designing circuits that are tolerant of the variations in part characteristics. A method of testing circuits for tolerances, and instrumentation of this method, are described in this presentation. Basically different approaches to the evaluation of circuit tolerances are:

1. Find the expected variation of the circuit characteristics as a function of the variations in part characteristics.
2. Show that the circuit will function properly with part variations at least as great as those expected.

The first method is preferable because it gives more information, permits optimization of the design, and contributes greatly to adequate maintenance. The latter method has the advantages of a go/no-go test.

IRE paper presented at the Western Electronic Show and Convention (WESCON), San Francisco, August, 1959, and published in 1959 IRE WESCON Convention Record, Part 6, pp. 38-45.

DC Adjustable-Speed Drives

Don W. Smith, Application Engineer, Reliance Electric & Engrg. Co.

A guide to the use of dc adjustable-speed drives as final elements in process control systems. The most intriguing feature of electrical drives is high response rate at high power. Other advantages include easy and flexible signal manipulation, and savings of space.

In processes involving high-polymer chemistry, electrical adjustable-speed drives are almost the only means of control. Characteristics of the product prohibit the use of throttling valves and, therefore, variable-speed pumps are employed. The dynamics of a fluid system without storage require extremely fast response provided by electrical drives.

ISA Paper No. 54-59 presented at the 14th Annual Instrument-Automation Conference and Exhibit, Chicago, September, 1959, 6 pp.

Electrical Motorized Wheels

H. J. McLean and H. Vitt, Locomotive and Car Equip. Dept., General Electric Co.

Concept of an electric motor mounted inside the rim of a large wheel, and results of field service tests. Four of these motors can deliver the full output of engines rating up to 1600 hp for traction. The system is designed to provide 60 per cent adhesion on all wheels at standstill and full horsepower utilization over most of the speed range to a maximum of 35 mph.

SAE Paper No. 92T, "Electrical Drive for Off-Highway Vehicles," presented at the SAE National Farm, Construction, and Industrial Machinery Meeting, Milwaukee, September, 1959, 13 pp.

Using Magnetic Amplifiers As Electrical Power Controllers

William G. Beyer and Robert S. Day, Leeds & Northrup Co.

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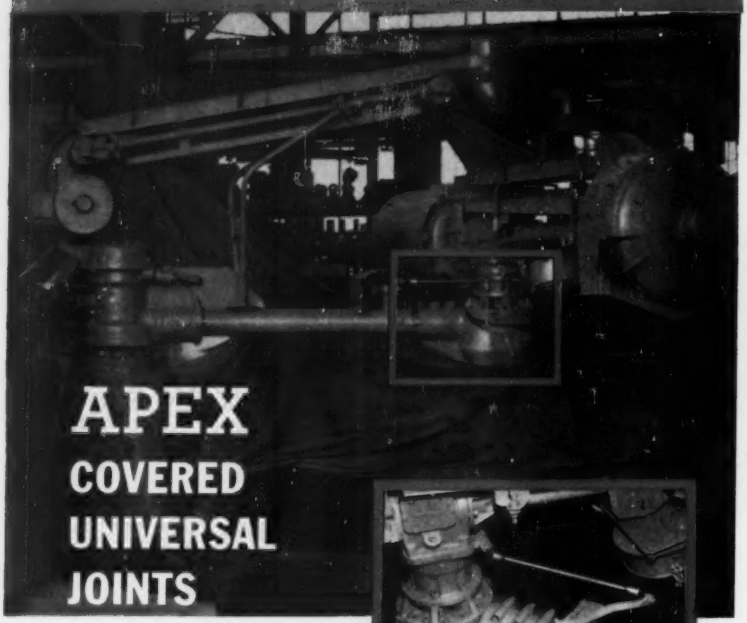

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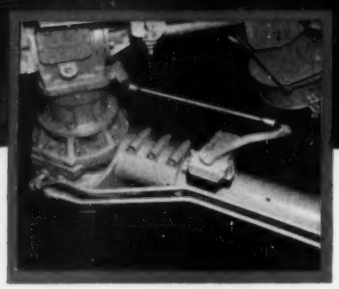

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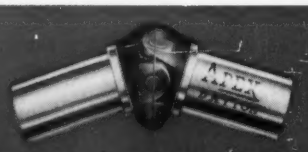

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Operation of a magnetic amplifier is such that a uniform increase in the control current causes the gate winding to present a decreasing impedance to the a-c input terminals. By varying this series impedance, a greater or lesser amount of current is allowed to flow.

ISA Paper No. 2-59 presented at the 14th Annual Instrument-Automation Conference and Exhibit, Chicago, September, 1959, 11 pp.

hydraulic

Calculating Burst Strength Of Braided Rubber Hose

Determination of the total burst strength for braided hose having two layers of reinforcing material. The approach is different from that usually used in analyzing hydraulic conduits because consideration must be given to the braided reinforcing material and the equipment used to fabricate the hose.

"Calculate the Burst Strength of a Braided Rubber Hose from Design Considerations," *General Motors Engineering Journal, Vol. 6, October-November-December, 1959, pp. 43, 44.*

Hydrostatic Transmissions

P. C. Mortenson, Director of Engineering, Mobile Hydraulics Div., Vickers Inc.

Characteristics and performance of hydrostatic and hydrokinetic transmissions, with emphasis on the former. Two types are recognized. The first consists of a variable pump and fixed motor. The second consists of a fixed pump and a variable motor. It is also possible to use two variable-displacement units to form a hydrostatic transmission. Such a combination is capable of delivering either fixed torque or variable torque from the output shaft. By proper control of the ends of this transmission, a great number of torque-speed relationships are avail-

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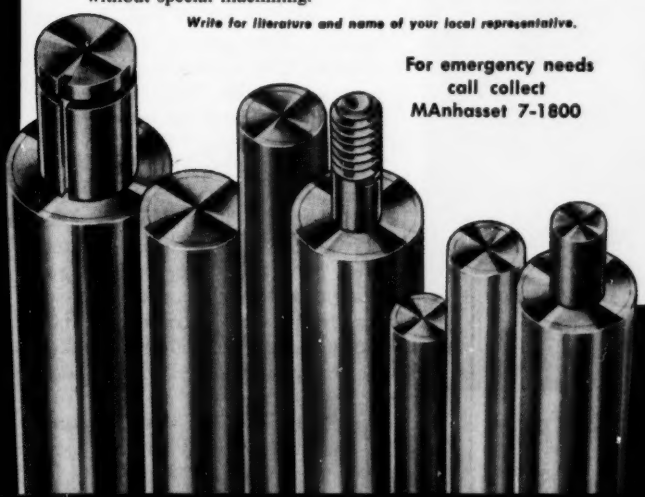

ADVANTAGES of *60 Case*

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- STRAIGHT PARTS
- DELIVERY FROM STOCK
- ADDED STRENGTH
- UNIFORM HIGH QUALITY

TYPICAL *60 Case* PARTS

GUIDE RODS, SHAFTING, ROLLS, TRAVERSE RAILS, PISTON RODS, ARBORS, LEADER PINS, TIE RODS, KING PINS, AXLES, CONTROL RODS, GUIDE POSTS, MANDRELS, BEARING ROLLERS, SPINDLES

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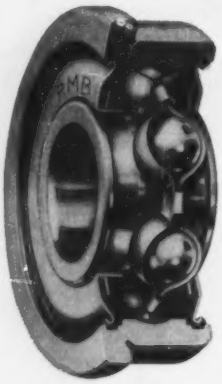

NEW!

RMB FLANGED, SEALED MINIATURE BEARINGS AVAILABLE IN ABEC 1, 5, 7, and THE NEW RMB ULTRA-PRECISE "GYROSCOPE QUALITY" TOLERANCES

New available in "Gyroscopic Quality" Tolerances, as well as the more familiar ABEC 1, 5, and 7, new RMB Filmoseal Flanged Bearings offer the engineer the ultimate in precision. Sizes range from 0.046" to 0.1875" bore—0.1562" to 0.375" OD.

RMB RF Filmoseal sealed miniature bearings combine all the advantages of sealed bearings with the rotational freedom of open bearings. Now you can get engineering features in bearings for small mechanisms that you would normally expect in larger size anti-friction bearings—There is no mechanical contact between rotating and stationary parts—Lubrication is retained and foreign matter excluded by oil encased, non-rubbing capillary seal.

Write to us for full details on these and the other miniature and instrument ball and roller bearings in the RMB line.

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45 West 45th Street New York 36, New York

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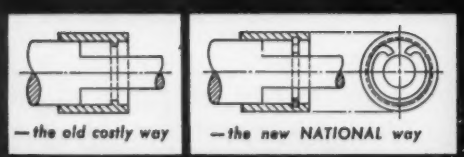

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Circle 507 on Page 19

able. Transmission of this type can theoretically provide the designer with an unlimited number of power-output performance characteristics.

SAE paper 92U, presented at the SAE National Farm, Construction, and Industrial Machinery Meeting, Milwaukee, September, 1959, 9 pp.

Industrial Servo Drives

John Marshall, Vickers Inc.

Characteristics of hydraulic drive components, and design techniques for their application. Use of fluids of extremely low compressibility in confined chambers results in a driving element stronger than steel and as flexible as the configuration of the containing chamber. Hydraulic components thus exhibit inherent characteristics of high torque and force capability per package size and an ability to change their output extremely rapidly. Such characteristics have made hydraulic components the logical selection in many cases where precise control is required.

ISA Paper No. 39-59 presented at the 14th Annual Instrument-Automation Conference and Exhibit, Chicago, September, 1959, 4 pp.

materials

New Ceramoplastic Insulating Materials

P. S. Hessinger and T. Weber, Mycalex Corp.

A report on newly developed high-temperature ceramoplastic dielectrics for electronic-component applications. These materials incorporate crystalline synthetic mica combined with special glass and ceramic binders. They are available in machinable and moldable grades and operate in the high-temperature ranges established for critical military applications. The low-loss, high-resistivity machinable grade ceramoplastic is dimensionally stable to 1550 F. This represents a 60 per cent increase in heat resistance over standard glass-bonded mica and ceramoplastic materials. It may be machined using standard techniques to tolerances of 0.0001 in. The moldable ceramoplastic,

for use at 932 F, can be precision molded to close tolerances, and metal inserts can be used. Its specific gravity of 2.7 approximates that of aluminum alloys. Specific applications, physical properties data, and test data are included.

New Ceramoplastic Insulating Material, Mycalex News, *Vol. 1, No. 1, pp. 5.*

Nodular Iron as Gear Material

J. B. Hopper, Chief Engineer, Lufkin Foundry & Machine Co.

Examples of nodular iron gears used as an economical substitute for steel gears without sacrificing quality or performance. Nodular iron is within the range of the tensile strength of the alloy steel normally used for gears. It has appreciable ductility, high endurance strength, and good impact resistance. An important factor is that nodular iron has a low modulus of elasticity—25 million psi—appreciably lower than that for steel. This characteristic gives nodular iron the capacity to deform under load with a lower surface-contact stress than the same load would induce in steel.

AGMA paper 249.07 presented at the Semi-Annual Meeting of the AGMA, Chicago, October, 1959, 7 pp.

Materials for Equipment Operated below −100 F

O. A. Hansen, Engineering Consultant, Linde Co., Div. of Union Carbide Corp.

Low-temperature characteristics of a few common metals, and unusual problems created by low-temperature operation. Treatment of materials before fabrication, methods of fabrication, and test procedures leave a marked effect on the finished article.

ASME Paper No. 59-PET-37 presented at the Petroleum Mechanical Engineering Conference, Houston, 5 pp.

Creep-Rupture Behavior Of Three Stainless Steels

F. Garofalo
Research Center, U. S. Steel Corp.

Creep-rupture behavior of types 304, 316, and 321 austenitic stainless steels at 1100 and 1500 F. Based on the ratio of the notched creep-

QUALITY TOKHEIM BUILDS PERFORMANCE IN . . . AND MAINTENANCE OUT . . .

IN NEW "MIRACLE METER" WITH

RULON® CUP PACKING . . . AND 9 OTHER RULON PARTS

TOKHEIM CORP. of Fort Wayne, Ind., leading manufacturer of gasoline pumps, needed a tough material for the cup packing of their new meter's plunger-assembly. Only Dixon's Rulon (reinforced Teflon) had the right combination of chemical *and* physical characteristics to withstand attack from all types of gasoline additives, and *also* stand up under the mechanical stress and wear of millions of plunger cycles. As a result of rulon's performance, it is used in 9 other places as shaft seals, thrust washers and sleeve bearings.

- **RULON resists deformation** — hugs cylinder walls, prevents leakage, maintains meter accuracy.
- **RULON reduces drag** — low coefficient of friction insures smooth operation—even in non-lubricating media (gasoline).
- **RULON wears longer** — tougher than Teflon, Rulon cuts costly maintenance . . . requires no lubrication.
- **RULON is completely inert** — doesn't change properties or swell in presence of liquids.

Look at your designs with RULON in mind. If it's a bushing, bearing, cam, wear strip, or insulator, chances are the combination of the correct RULON formulation plus DIXON's manufacturing capabilities can produce the exact component you need. *One of Dixon's many modifications of DuPont TFE Teflon.

For engineering data sheet 129-8, write . . .

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Bristol, Rhode Island

Check these outstanding properties of RULON

- Resistance to wear: 500 times Teflon
- Low coefficient of friction: 0.10-0.24
- Wide temperature range: −300° to +500°F
- Excellent electrical properties: Resistivity 10^{15}, dielectric constant 2.6, dissipation factor .002
- Chemically inert — Zero water absorption — Weather resistant
- Low coefficient of expansion: 3.3×10^{-5} (½ that of Teflon)
- Low deformation under load: ½ that of Teflon

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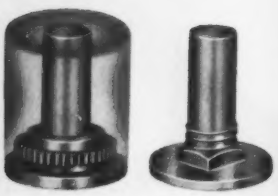
A SAVING OF OVER $40.00 per thousand pieces



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THE PROBLEM:
Cut costs on a special fastener blank used as insert in plastic knob.

SPECIAL REQUIREMENTS:
Fastener must have surfaces that grip into plastic and hold fast when knob is pulled laterally or turned.

SOLUTION:
Redesign to simplify gripping surfaces. Production by Clark Cold Heading process (instead of machining from bar stock).

SAVINGS:
In steel ....$19.70 per 1 M pcs.
In labor, over 21.00 per 1 M pcs.
TOTAL, over $40.00 per 1 M pcs.

It's quite possible that Clark Cold Heading can effect equally impressive savings on *your* special fasteners.

Send sample (or blueprint) for prompt analysis and quotation *... at no obligation.*

CLARK BROS. BOLT CO.
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Circle 509 on Page 19

rupture strength to the unnotched creep-rupture strength, for equivalent rupture times, types 304 and 321 are notch-strengthened for short rupture times at 1100 F. For intermediate rupture times, a slight notch-weakening effect is found. Beyond about 1000 hr a tendency toward notch strengthening for both steels is again found. For type 316 material, a mild notch-strengthening effect is found at 1100 F for all periods studied. At 1500 F all three steels exhibit notch strengthening.

ASTM Paper No. 77, presented at the 62nd Annual Meeting, June, 1959, 16 *pages.*

New Protective Finishes For Magnesium Alloys

P. F. George, Dow Metal Products Co.

Properties and processes include:

Electroless Nickel: A process for plating nickel directly onto magnesium without electric current. Plating is uniform over all surfaces of complicated shapes.

Anodize Impregnation: This process combines the sealing of porous areas of castings with simultaneous formation of a protective paint base.

Ferric Nitrate Bright Pickle: An all-purpose pickle for all alloys, this process is low in cost, needs little replenishing, is not apt to strain in rinsing.

Organo-Tin Inhibitor: Addition of an organo-tin compound to paint primer, replacing the zinc chromate, inhibits the galvanic corrosion of magnesium when coupled to a dissimilar metal.

Compatible Aluminum Alloy: Test data point out the necessity for using a high-purity 5056 aluminum rivet with magnesium alloys when the assembly is going to be subjected to 300 to 400 F.

"Recent Developments in Protective Finishes for Magnesium," *presented at the 15th Annual Convention of the Magnesium Association, New York, October,* 1959, 4 *pp.*

mechanical

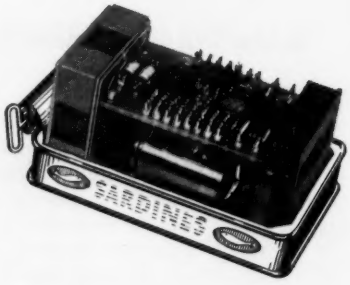
Equations from Overstrain Tests On Thick-Walled Steel Cylinders

S. M. Jorgensen, Foster Wheeler Corp.

Pressure-expansion tests, and equations derived from them, for thick-walled closed-end cylinders made of four different steels. The tests covered stress levels through the plas-

SPECTROL PRECISION MECHANISMS

The Big Squeeze Job



SPECTROL'S new PRECISION MECHANISM—a velocity servo—is more than just another interesting shrink job. It's useful. It can go anywhere you need an ultra-miniature, precision speed control device.

First, the package. It measures only 1½ x 1½ x 3 inches. In a space that would give a sardine claustrophobia, Spectrol engineers squeezed a solid-state amplifier, a servo-motor, a gear train, and a very special, condensed (½-inch long) potentiometer and switch.

The pot has four electrically isolated wipers, all riding 90° apart on the same coil. The switch, in the same pot housing, has four wipers riding on an alternately conducting and non-conducting surface.

THE FUNCTION: The servo accepts dc signals varying between ±10 v from a computer to drive the pot in such a manner that speed is directly proportional to the dc signals.

THE APPLICATIONS: Here's an example: tied to an airborne computer, the Spectrol servo will drive a scope in the cockpit of one of the nation's hottest aircraft. The object: to give the pilot a visual, three-dimensional analog of his position. Actually, the servo will drive anything—resolvers, synchros, tachs, other pots and switches. It's a complete, ready-to-go package you can put into your system as is.

This is another example of how Spectrol PRECISION MECHANISMS free the systems engineer from building functional subassemblies using components such as gear drives, clutches, precision potentiometers and servomotors. If you need modules combining any of these components in a *single specification*—Spectrol can help.

For more details, call your Spectrol engineering sales representative, or address Dept. 5712

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News and Notes on...

Good Packing Practice

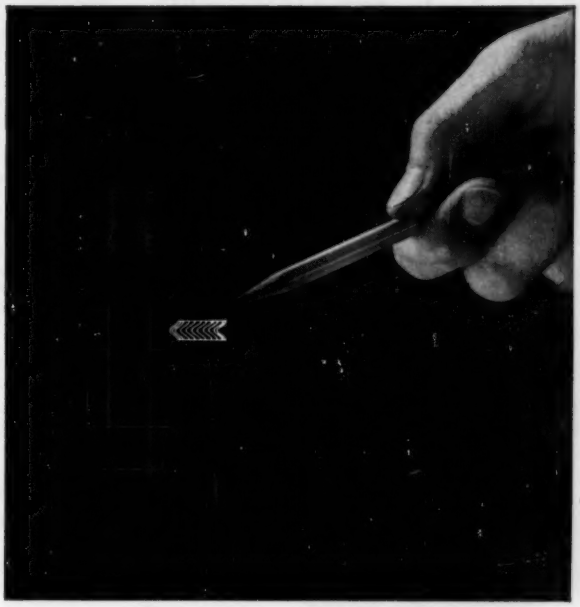
JOHNS-MANVILLE JM PRODUCTS

Maintenance and Design Hints from Johns-Manville Packings and Textiles Dept.

Subject of the month: Selecting the Gasket

Question:

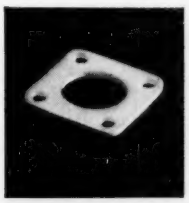
What are the important points to remember about gasket applications so we can avoid costly failure?



GASKET engineering is a complex study, but there are certain simple answers to this commonly asked question. Briefly, at least three variables must be considered. These are: 1. The available bolt force on the gasket. 2. Internal pressure and temperature. 3. The nature of the contained fluid.

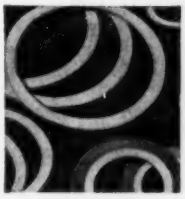
Starting with bolt force: it must be adequate to flow the gasket material and cause it to yield and seat effectively. Secondly: the bolt force must also always be sufficient to exceed the internal pressure and temperature forces that work against gasket closures. Finally: the gasket material must be impervious to the action of the confined fluid.

For service at low to medium temperatures and pressures: As a rule of thumb, if multiplying the operating pressure (psi) by operating temperature (°F) results in a product not exceeding 250,000, a quality "general service" type gasket can be used with complete safety. An outstanding gasket material for these operating conditions is J-M Service® Sheet #60 . . . a tough, durable compressed asbestos sheet. Service Sheet seals effectively against hot or cold water, steam, oils, mild acids and caustics.



If corrosive fluids are encountered: The best solution to the constant attack of chemicals and solvents is a gasketing material that is chemically inert. For this kind of service condition, Johns-Manville Teflon* Chempac® Gaskets are recommended. They are available in pure Teflon, low-flow (glass-filled) Teflon, Teflon-Asbestos, and in metal-Teflon combinations.

*TM for DuPont Tetrafluorethylene resin.



When extreme pressures and temperatures act on the gasket: If internal pressures reach 1200 psi or temperatures exceed 850°F, safe practice calls for a sturdy gasket that offers the high resiliency needed to follow expanding and contracting movements of flanges. For standard flange applications to 6,000 psi, you will find metal-asbestos, spiral-wound Goetze Spirotallic® gaskets most efficient. They offer high mechanical strength and resilience. Their special interlocking design and stainless steel construction is especially designed to effect and maintain a tight seal despite wide pressure and temperature variations.

To solve any sealing problems, call your J-M Packings and Gaskets field representative. He's equipped to give you information on new products . . . engineering and design advice. For information on any J-M Packings or Gaskets write Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

JOHNS-MANVILLE

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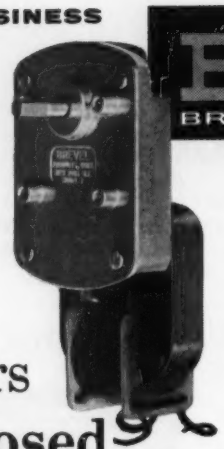
SLOW MOTION IS OUR BUSINESS



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Brevel "F" motors have **fully-enclosed gear trains;** provide maximum protection of gears against dirt.

Designed to give maximum power transmission at lowest noise level by use of specially cut helical gears. Optional features—brake, clutch, and cooling fan—make it suitable for a wide variety of applications. Like all Brevel Motors, this new "F" Motor provides reliable power at low cost. ***Write, wire, or phone today for Catalog 28R.*** You will receive information on Brevel's complete line of small gear head motors.

BREVEL

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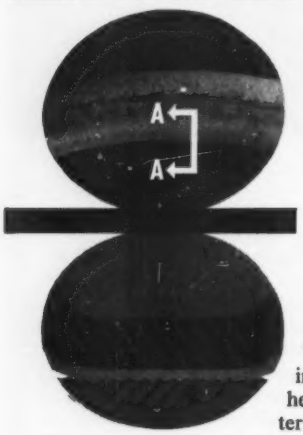


TOP: Tool marks visible in TEFLON coating, magnified 12X.

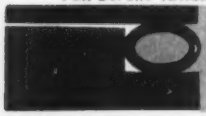
BOTTOM: Section A-A TEFLON . . . conforms to irregularities in machined surface.

PERFECT SEAL . . .

Teflon* coating mates United's metallic O-ring to surface!

Teflon, permanently bonded to a United metallic O-ring, conforms to normal tool marks which it contacts in a machined seat. This remarkable, non-porous, pliable coating compresses into these irregularities to help form a perfect seal. Spring steel characteristics of the O-ring metal are retained, and the surface conformability of a rubber-like compound is added. Finish is completely non-corrosive and resistant to chemical action. Tests with gases and liquids, at high and low pressures, prove absolute sealing action. United also makes hollow tube; pressure-filled; and patented† self-energized metallic O-rings; and wire and brazing O-rings to practically any required dimensions. Write for information (on your letterhead please).

*TEFLON IS THE REGISTERED TRADEMARK FOR DUPONT TETRAFLUOROETHYLENE RESINS. † PATENTS 2,809,269; 2,837,360



UNITED METALLIC "O" RING CORP.

Dayton, Ohio • Box 1035

Division of United Aircraft Products, Inc.

tic and strain-hardening ranges to destruction, at pressures up to 100,000 psi. A theoretical method is given for computing expansion and bursting strength, based on both tension and torsion data. Also, a simplified formula for ultimate pressures is described and checked against the experimental data.

ASME paper 59-PET-1 *presented at Petroleum-Mechanical Engineering Conference, Houston, Texas, September,* 1959, 14 *pp.*

Adjustable-Speed Drives As Final System-Control Units

Martin P. Despins, Reeves Pulley Co.

Description of the pneumatically controlled, electrically powered adjustable-speed drive and its application as a final control component in systems. The drive offers a means of extending process control to the flow of solid materials as well as the more common applications involving the control of liquids.

Condensed observations are:

1. The mechanical adjustable-speed drive may be coupled to a pump, conveyor, or blower to form a final control element.
2. A typical drive operates from a 3 to 15 psi pneumatic signal, and produces an output speed directly proportional to input signal.
3. The frequency-response characteristics of the final control element are suitable for open and closed-loop control of most industrial processes.
4. The drive is limited to applications requiring less than 60 hp, and less than a 10:1 speed range.

ISA paper 4-59 *presented at the* 14*th Annual Instrument-Automation Conference and Exhibit, Chicago, September,* 1959, 12 *pp.*

Using Mechanical-Traction Constant-Speed Drives at 600 F

C. D. Flanigan, Chief Engineer, Lycoming Div., Avco Corp.

Problems and achievements in developing a mechanical-traction constant-speed drive operable at 600 F. Conclusions are:

- Materials and lubricants that are compatible at 600 F have been selected.
- Power transmission at 600 F has been demonstrated with indications of improvement to come.

- The mechanical constant-speed drive has been controlled well at 600 F.
- Typical mechanical components have operated individually and in combination at 600 F. Approximately 90 hours of test at 600 F have been accumulated, with many more at temperatures above 400 F.
- Electronic components and suitable circuits have been operated at 650 F. A total of about 6000 hr of test time has been accumulated at this temperature.
- A breadboard drive, containing all the selected high-temperature materials has completed a 100-hr endurance test, 20 hr of which were at 600 F.
- Two of these drives have demonstrated the ability to automatically parallel two alternators. Load sharing between alternators was satisfactory.
- The principal work remaining to be done is the development and qualification of the final article.

SAE paper 102U presented at the SAE National Aeronautics Meeting, Los Angeles, October, 1959, 18 pp.

processes

Fabrication with Adhesives

A. J. Slosser, Armstrong Cork Co.

Considerations in the design of adhesive joints, mainly metal-to-metal. Joints should be designed to:

1. Minimize stress on the adhesive.
2. Stress the adhesive in the direction of its maximum strength.
3. Minimize stress in the direction the adhesive is weakest.
4. Make the maximum proportion of bonded area contribute to the strength of the assembly.
5. Maintain continuity of bond.
6. Be adaptable to production techniques.

Major factors influencing the design of a metal-to-metal joint are duration, magnitude, and direction of loads to be applied. Joints usually are designed to place the adhesive in shear, and prevent or minimize peel or cleavage stresses. Flat plates or sheets are rarely bonded in a manner to place the adhesive in tension.

Cylindrical or tubular butt joints have limited contact area unless heavy wall thicknesses are involved.

Presented at the Industrial Adhesives

CAMLOC *low cost/light weight*

5F series

Camloc's new small, lightweight 5F Series features high strength-weight ratio plus the quick-operating advantages of a ¼-turn fastener... in a size and weight that offers new design possibilities to original equipment manufacturers! Particularly adaptable to thin materials and miniaturized equipment like airborne electronics, small electro-mechanical and computing devices and communications components. Ideal for attaching lightweight components in "packaged" equipment or for holding access panels on everything from washing machines to radar units.

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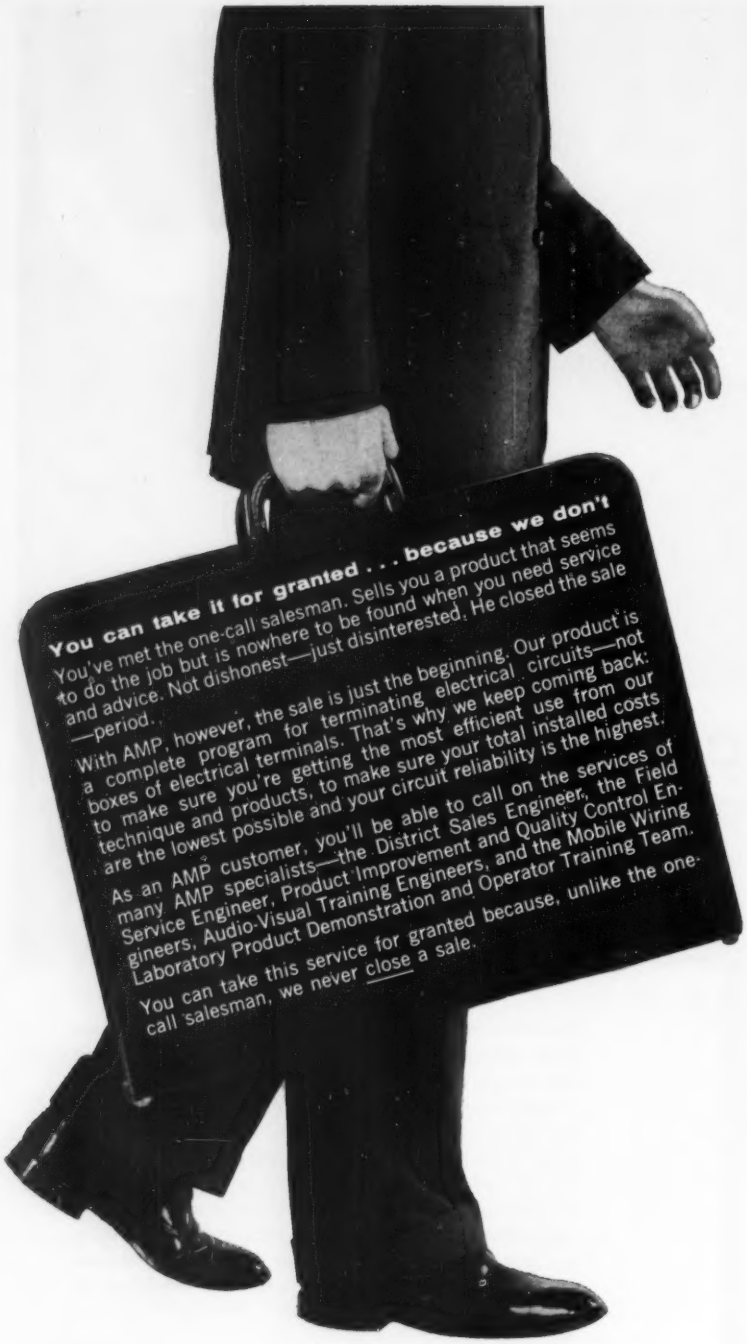
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You've met the one-call salesman. Sells you a product that seems to do the job but is nowhere to be found when you need service and advice. Not dishonest—just disinterested. He closed the sale—period.
With AMP, however, the sale is just the beginning. Our product is a complete program for terminating electrical circuits—not boxes of electrical terminals. That's why we keep coming back: to make sure you're getting the most efficient use from our technique and products, to make sure your total installed costs are the lowest possible and your circuit reliability is the highest.
As an AMP customer, you'll be able to call on the services of many AMP specialists—the District Sales Engineer, the Field Service Engineer, Product Improvement and Quality Control Engineers, Audio-Visual Training Engineers, and the Mobile Wiring Laboratory Product Demonstration and Operator Training Team.
You can take this service for granted because, unlike the one-call salesman, we never close a sale.

Write for more information on our electrical wire terminating program.

AMP INCORPORATED

General Offices: Harrisburg, Pennsylvania

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Applications Institute, University of Wisconsin, Madison, Wis., October, 1959, 16 *pp.*

techniques

Microminiaturization With Refractory Metals

D. A. McLean, Bell Telephone Laboratories

A concept of integrated circuitry involving the production *in situ* of the capacitors and resistors and their principal interconnections on a glass or ceramic substrate from a single metal.

While this approach to microcircuitry is quite different from the micromodule concept, individual components and small subassemblies can be produced by the same methods.

IRE paper presented at the Western Electronic Show and Convention (WESCON), San Francisco, August, 1959, *and published in* 1959 *IRE WESCON Convention Record, Part* 6, *pp.* 87-91.

TO OBTAIN COPIES of papers or articles abstracted here, write directly to the following organizations:

AGMA — American Gear Manufacturers Association, One Thomas Circle, Washington 5, D. C.

ASA—American Standards Association, 70 East 45th St., New York 17, N. Y.

ASME—American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.

ASTM—American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

General Motors Engineering Journal, G. M. Technical Center, P. O. Box 177, North End Station, Detroit 2, Mich.

IRE—The Institute of Radio Engineers, 1 East 79th St., New York 21, N. Y.

ISA—Instrument Society of America, 313 Sixth Ave., Pittsburgh 22, Pa.

The Magnesium Association, 122 East 42nd St., New York 17, N. Y.

SAE — Society of Automotive Engineers Inc., 485 Lexington Ave., New York 17, N. Y.

University of Wisconsin, University Extension Div., 3030 Stadium, Madison, Wis.

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1. METAL PISTON ROD SCRAPER—protects rod packing, cylinder bore and rod surface by removing all foreign particles.
2. NEW "SUPER" CUSHION for air or METALLIC SELF-ALIGNING MASTER CUSHION for oil.
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4. ONE PIECE PISTON assures better alignment, longer bearing and packing life.
5. FORGED SOLID STEEL HEADS throughout entire line.
6. PILOTED PACKING GLAND with extra long bearing for additional strength and support to piston rod.
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8. STREAMLINED DESIGN . . . operating pressures to 200 PSI, air; 1,000 PSI oil, non-shock.

Specify the

T-J Spacemaker

for longer, more efficient cylinder service

You too—can reduce replacement expenditures—lower maintenance costs with the T-J Spacemaker cylinder line. Designed and engineered for ruggedness, and accuracy of operation, the Spacemaker assures longer, uninterrupted operation.

The T-J Spacemaker eliminates tie-rods, gives greater strength, saves space . . . and reduces costs in all push-pull operations. Immediate delivery in a complete range of styles and capacities . . . air or oil. Write for Bulletin SM 155-4, today. The Tomkins-Johnson Company, Jackson, Michigan.

T-J TOMKINS-JOHNSON

RIVETORS . . . AIR AND HYDRAULIC CYLINDERS . . . CUTTERS . . . CLINCHORS

Circle 516 on Page 19

MANY WRONGS MAKE OUR SLEEVE BEARINGS JUST RIGHT

The scores of design errors we have encountered in 25 years of bronze bearing production comprise one of the most valuable benefits we can offer you — *experience*. The experience to help you with design problems, to suggest a slight change which will not affect performance but will save production costs, to use the correct alloy for optimum bearing life or to provide the proper lubrication system.

It is this experience that gives us the confidence to offer the largest variety of bronze bearings available anywhere . . . a full range of sizes in both cast and sintered bearings including grooved and graphited items.

Be sure to take advantage of this specialized knowledge the next time you have a bearing problem. Let us help you avoid the pitfalls of others. We will welcome your inquiries.

See the coupon below for some information you should have in your files.

A Founding Member—
Cast Bronze Bearing Institute

RENEWAL SERVICE INC.
1703 Lehigh Ave., Phila. 32, Pa.

Send me "Chemical and Physical Specifications of the Bronze Alloys" which includes MIL., SAE, Navy, Aero., ASTM, and Fed. Spec. Comparatives.

Name_____

Company_____

Address_____

Renewal Service INC.

Circle 517 on Page 19

Helpful Literature for Design Engineers

For copies of any literature listed, circle Item Number on Yellow Card—page 19

Variable Speed Sheaves

Resilient cam-follower design of MCS variable-speed sheaves eliminates freezing and sticking, and will hold a constant driven speed under varying torque loads. Bulletin 8102 describing these sheaves also tabulates selection data for companion sheaves and belts. 8 pages. T. B. Wood's Sons Co., Chambersburg, Pa. E

Circle 701 on Page 19

Mass Flowmeter

Accurate measurement of gas or liquid flow, even with wide variations of pressure, temperature, density, and viscosity, is made by the G-E Gyro-integrating mass flowmeter. It is described in Bulletin GEA-6925. 4 pages. General Electric Co., Instrument Dept., West Lynn, Mass. B

Circle 702 on Page 19

Permanent Magnets

Magnetic and material characteristics of Hyflux Alnico V-7 permanent magnets, as well as many applications for the new material, are covered in Engineering Form 350. It emphasizes uses in lightweight ground or airborne generators, alternators, and recorders. 2 pages. Indiana Steel Products Co., Valparaiso, Ind. J

Circle 703 on Page 19

Specialty Steels

As a reference source, buyers' guide for specialty steels provides details on tool and die steels, stainless steels, high temperature alloys, electronic and magnetic alloys, special-purpose alloys, tubing and pipe, and fine wire specialties. 40 pages. Carpenter Steel Co., 320 W. Bern St., Reading, Pa. E

Circle 704 on Page 19

Hot Heading of Bolts

Volume 24, No. 2 of "Bolt News" points out how hot heading can furnish unlimited lengths in bolts, wider diameter ranges, and greater upsets. Hot heading adapts to all quantities, all configurations, and all metals. 8 pages. H. M. Harper Co., 8200 Lehigh Ave., Morton Grove, Ill. J

Circle 705 on Page 19

Ribbon Filter Elements

Application of Microbon ribbon filter elements in hydraulic oil, gasoline, air, lubricating oil, water, kerosene, and fuel oil systems is discussed with photos, drawings, curves, and tables in Brochure 44. These easily cleaned units will trap 40-micron particles. 4 pages. Bendix Aviation Corp., Bendix Filter Div., 434 W. 12 Mile Rd., Madison Heights, Mich. H

Circle 706 on Page 19

Industrial Wire Cloth

Filter, space, mesh, backing, bolting, centrifugal, galvanized wire, and extra fine wire cloths are covered in descriptive bulletin. It also tells how to select and check wire cloth. 4 pages. Newark Wire Cloth Co., 351 Verona Ave., Newark 4, N. J. D

Circle 707 on Page 19

Hydraulic Hose Couplings

Guide for hydraulic hose and assemblies covers couplings, coupled assembly lengths, permanent type Full-Flo couplings, reusable couplings, and pipe thread adapter unions. Hose price list is supplemented. 16 pages. Hydraulics Inc., 42 Lafayette St., Newark 2, N. J. D

Circle 708 on Page 19

Oilers & Oil Controls

Circular 580 covers automatic constant oil level controls, bottle oilers for plain bearing lubrication, glass body oil cups, and aluminum body oil cups for severe industrial service. 4 pages. Lunkenheimer Co., Box 360, Cincinnati 14, Ohio. G

Circle 709 on Page 19

Protective Surfacing

Test results obtained with molybdenum protected by the Chromalloy W-2 surface coating are described on Data Sheet 34. Application enables metal to be used at temperature of 2000° F under static oxidation conditions. 1 page. Chromalloy Corp., 450 Tarrytown Rd., White Plains, N. Y. D

Circle 710 on Page 19

Stainless Comparison

Properties for 18 different grades of stainless steel, including recently developed precipitation hardening Grades 17-4 and 17-7, are compared on data chart. 2 pages. Peter A. Frasse & Co., 17 Grand St., New York 13, N. Y. D

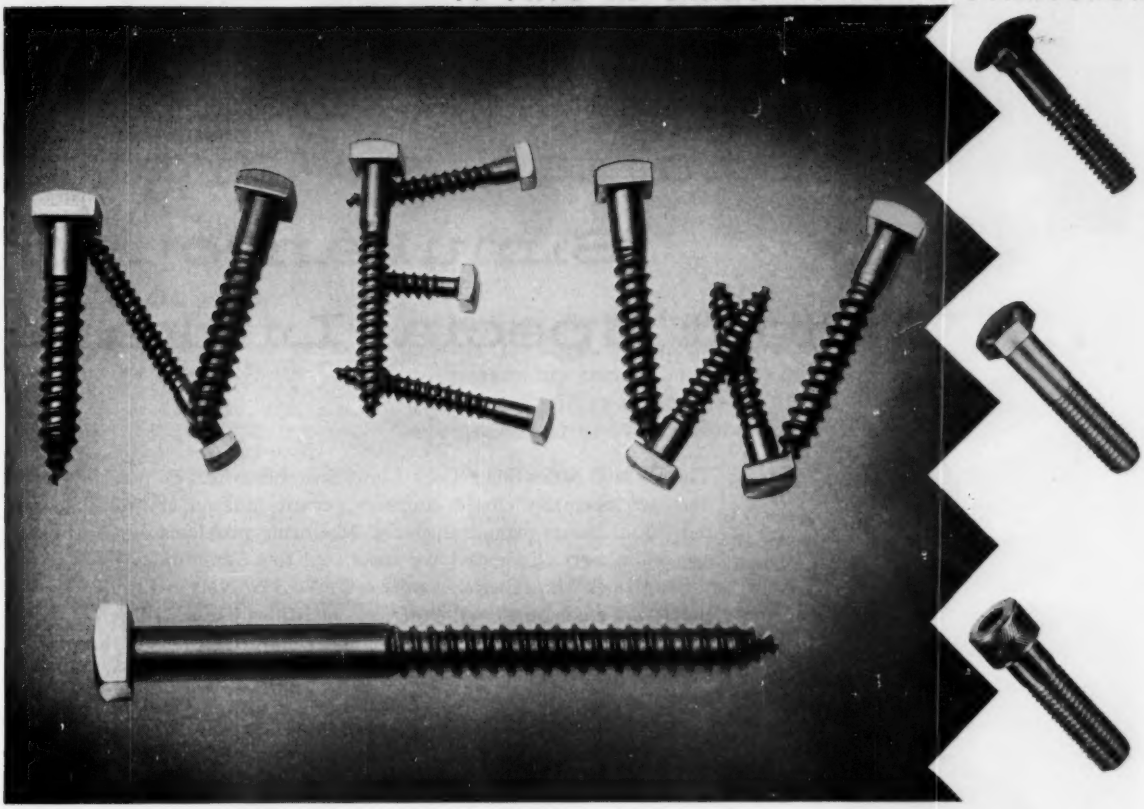
Circle 711 on Page 19

Ground Support Equipment

Ground support equipment systems, components, and capabilities for aircraft and missiles are described in illustrated Bulletin GR-317. Basic units covered are available as components or as groupings for complex systems. 4 pages. Lear, Inc., Box 688, Grand Rapids 2, Mich. T

Circle 712 on Page 19

IT PAYS TO STANDARDIZE ON **STANSCREW**



Lag Bolts Expand Stanscrew Line To Over 5,500 Different Fasteners

Hex machine bolts . . . carriage bolts . . . and now, a broad selection of lag bolts . . . all quickly available from Stanscrew.

These new gimlet point lag bolts, all with full-sized shanks, conform to ASA Standards and are produced to Stanscrew's rigid criteria of fastener quality. Almost 100 sizes are offered as stock items.

With lag bolts, the Stanscrew line now covers more than 5,500 standard catalogued fasteners . . . carefully developed to answer the overwhelming majority of American industrial needs. Included are socket, set, and cap screws . . . nuts . . . dowel and taper pins . . . pipe plugs . . . studs . . . and, of course, Stanscrew's complete bolt series.

Each of these 5,500 fasteners is always in stock at three conveniently located plants. A rigidly enforced Stanscrew policy assures regular orders are shipped within 24 hours. This means your Stanscrew distributor can provide especially fast service on all occasions . . . and be particularly helpful in emergencies.

Your Stanscrew distributor will also be happy to arrange a visit from the Stanscrew fastener specialist. His recommendations on your assembly procedures can often result in significant savings. Why not call your Stanscrew distributor today?

STANSCREW FASTENERS

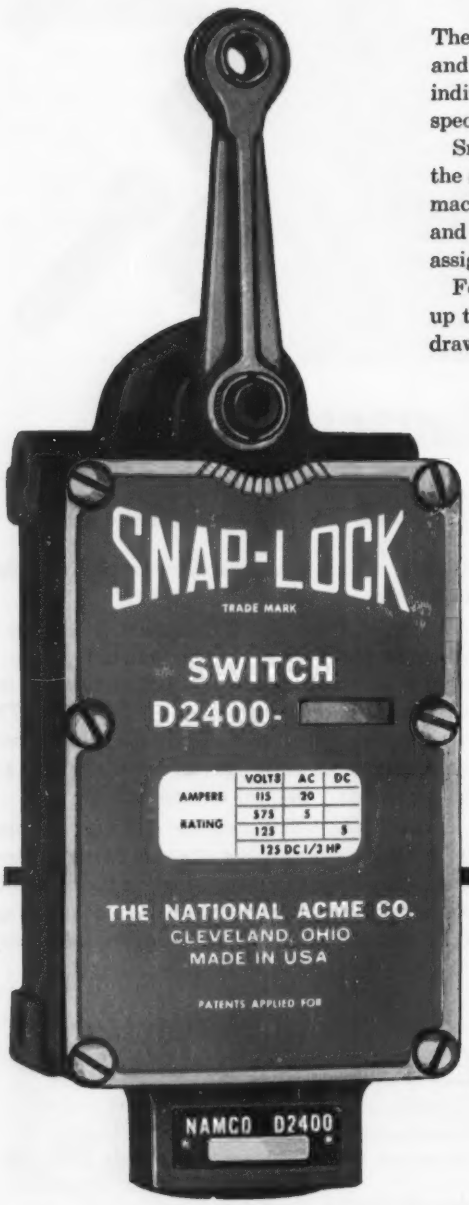
CHICAGO | THE CHICAGO SCREW COMPANY, BELLWOOD, ILLINOIS
HMS | HARTFORD MACHINE SCREW COMPANY, HARTFORD, CONNECTICUT
WESTERN | THE WESTERN AUTOMATIC MACHINE SCREW COMPANY, ELYRIA, OHIO

STANDARD SCREW COMPANY 2701 Washington Boulevard, Bellwood, Illinois

Circle 518 on Page 19

SNAP-LOCK Limit Switches

Actuate Two Circuits Simultaneously ...Without Special Linkage



The D-2400 series Snap-Lock Limit Switches with two normally open and two normally closed contacts permit making or breaking two individual circuits simultaneously. Mounting problems are simplified, special linkages eliminated and costs kept to a minimum.

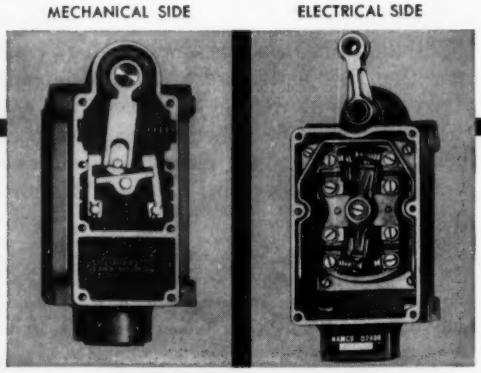
Snap-Lock Limit Switches were originated by National Acme to meet the severe mechanical and electrical conditions imposed by all types of machine tools. The outstanding simplicity and ruggedness of these water and oil tight switches make them adaptable to the toughest heavy-duty assignments.

Four basic models with a wide variety of actuating levers will handle up to 5 amps, 600 volts, AC. For complete details, parts list, and scale drawings, write for Bulletin EM-5824.

National Acme

THE NATIONAL ACME COMPANY
188 E. 131st STREET
CLEVELAND 8, OHIO

Sales Offices: Newark 2, N. J., Chicago 6, Ill., Detroit 27, Mich.



All Snap-Lock switches have separate enclosures within a single housing for the mechanical and electrical sides. Ample wiring space is provided and maintenance greatly simplified.

Circle 519 on Page 19

Hose Swivels

Straight-through, built-in check valve, and universal joint-double swivel types of hose swivels are detailed in Bulletin F-43-RE. Cross sectional views, specifications, and application data are included for the ¾ and 2-in. 125-psi bronze and aluminum swivels. 4 pages. OPW-Jordan, 6013 Wiehe Rd., Cincinnati 13, Ohio. G

Circle 713 on Page 19

Extruded Aluminum Alloys

Information on aluminum alloys and the aluminum extrusion process is contained in revised Technical Bulletin 5909. Mechanical properties and recommended uses are covered for shapes, rods, bars, and tubing. Different basic extrusion types are described and illustrated. 12 pages. Precision Extrusions, Inc., Green Street, Bensenville, Ill. J

Circle 714 on Page 19

High Strength Steel

Viscount 44 is a prehardened machinable high strength steel with a hardness range of Rockwell C 42-46. It meets strength requirements up to 200,000 psi without further heat treatment. Engineering and application data are found in bulletin. 4 pages. Latrobe Steel Co., Latrobe, Pa. F

Circle 715 on Page 19

Magnetic Separators

Working pressures from 2000 to 5000 psi in the PH Series and up to 3000 psi in the aircraft PX Series are ratings of high pressure Ferrofilter magnetic separators outlined in illustrated bulletin. Operational data are included. 4 pages. S. G. Frantz Co., Box 1138, Trenton 6, N. J. E

Circle 716 on Page 19

Glass-Epoxy Laminates

Grade GEC-111 glass base epoxy-resin laminated plastic and Grades GEC-111 E and GEC-111 R copper-clad laminates are detailed in Technical Bulletins 51.5.18 and 51.5.19. Their properties are given. 2 pages each. Taylor Fibre Co., Norristown, Pa. E

Circle 717 on Page 19

Planetary Gears

Space and weight-saving gears for speed reduction or speed increasing service in high horsepower transmission applications are described in illustrated Bulletin 2401. Eight sizes are covered. Capacity, selection, and construction data are included. 8 pages. De Laval Steam Turbine Co., Trenton, N. J. C

Circle 718 on Page 19

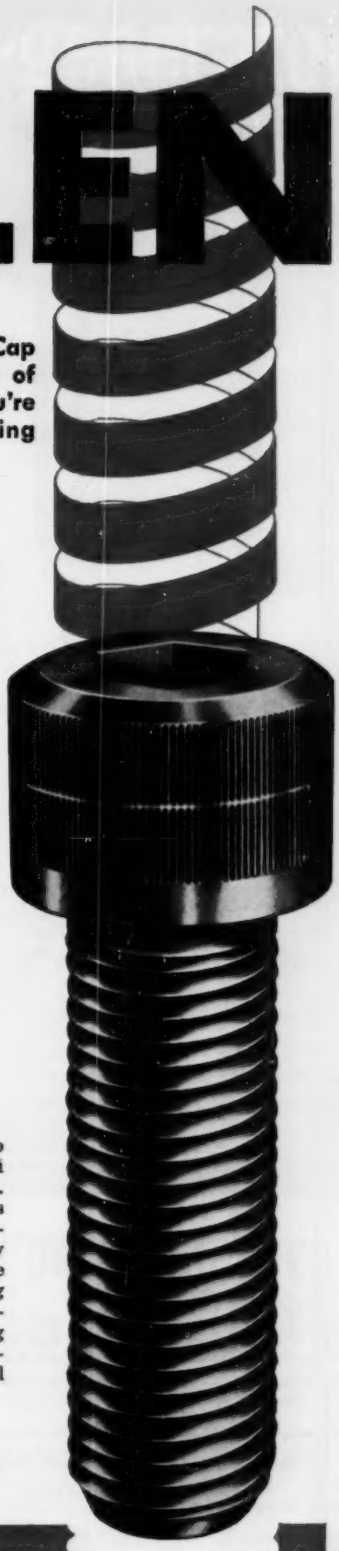
Rotary Switches

Lever actuated and solenoid operated Type MA-12 miniature rotary selector switches are detailed in Data Sheet 14-A. Dimensions, mounting data, and electric ratings are also given. 2 pages. Electro Switch Corp., 167 King Ave., Weymouth 88, Mass. B

Circle 719 on Page 19

ALLEN

The cost of ALLEN Hex-Socket Cap Screws is only a minor fraction of your assembly costs . . . be sure you're getting the timesaving, cost-saving advantages of genuine Allens!



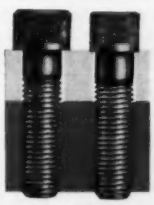
Ever since Allen first produced the hex socket head screw nearly fifty years ago, specifying *genuine* Allens (made by Allen of Hartford) has been a sure way to guarantee dependable threaded fastening.

Only *genuine* Allens have Leader Points that make starting easier, and greatly minimize danger of cross threading. *Genuine* Allens are "pressurformd" to preserve the long fibers uncut throughout the length of the screw, giving stronger sockets for greater tightening torque.

Write for samples and engineering data. See how *genuine* Allens will make your product better.

ALLEN HEAD HEX-SOCKET SCREWS

Allen's new 1960 Series Socket Head Cap Screws give up to 2⅓ times more load carrying capacity, without indentation. Head diameter of sizes from ¼" up is now uniformly 1½ times the body diameter—providing more under-the-head bearing surface, and a proportionate increase in clamping force. Write for new Bulletin G-25, with full specifications.



Stocked and sold by leading Industrial Distributors everywhere

ALLEN MANUFACTURING COMPANY
Hartford 1, Connecticut

Circle 520 on Page 19

Flange or Threaded Bushings for

VULCAN
IMMERSION HEATERS

Vulcan Electric Tubular Immersion Heaters offer a choice of flange or threaded bushings; bayonet type, side or bottom outlet; copper, steel, stainless or alloy sheath; single or three phase; 500 to 10,000 watts (or higher); 120, 240, 480 volts (or higher); pressures up to 3500 psi.

Vulcan Immersion Heaters are ideal for heat transfer to all types of liquids — water, oil, wax, paraffin, asphalt, tars, etc.; in tanks, boilers, urns, kettles and other containers.

Send coupon for complete information.

VULCAN ELECTRIC COMPANY Danvers, Mass.

Cartridges • Strip • Tubular • Immersion Electric Heaters • Soldering and Branding Irons Solder and Glue Pots

VULCAN ELECTRIC COMPANY, Danvers 6, Mass.

Please send catalog and prices on Vulcan Immersion Heaters.

Name & Title.....

Company.....

Street & No.....

City & State.....

Circle 521 on Page 19

HELPFUL LITERATURE

Reusable Batteries

Yardney PM Silvercel reusable primary batteries, subject of technical catalog, offer fast manual activation, with full power achieved in 5 to 30 min. Sizes from 0.1 to 200 amp-hr are available. Electrical and physical characteristics are presented. 6 pages. Yardney Electric Corp., 40-50 Leonard St., New York 13, N. Y. D

Circle 720 on Page 19

Precision Balls

Master table of ball grades and tolerances, a quick ball selector chart, new and previous AFBMA ball standards, and comprehensive data on balls made of many materials are found in "Precision Balls" catalog. General and specific characteristics are covered, including properties, machinability, hardness, and size. 16 pages. Hartford Steel Ball Co., 12 Jefferson Ave., West Hartford, Conn. B

Circle 721 on Page 19

Electric-Weld Tube

Requirements for cylinder tubing are met by Jal-Smooth, a drawn-over-mandrel electric-weld tube described in Bulletin AD-251. OD and ID tolerances, microinch finish of the ID, mill test pressures, and burst pressures are given for available sizes. 4 pages. Jones & Laughlin Steel Corp., Electricweld Tube Div., 3 Gateway Center, Pittsburgh 30, Pa. F

Circle 722 on Page 19

Available Alloys

Wide variety of ferrous and nonferrous alloys available from this company in such forms as pin, ticket, rope, spring, staple, and weaving wires is described in "Alloys for Industry" bulletin. Alloys include beryllium copper, brass, cupronickel, Inconel, Monel, and nickel silver. 4 pages. H. K. Porter Co., Riverside-Alloy Metal Div., Riverside, N. J. E

Circle 723 on Page 19

Epoxy Products

Descriptive data and suggested uses for Resiweld epoxy adhesives, sealants, alloys, and coatings are among content of plastic-bound Booklet No. 2. Properties and use directions are included. 42 pages. H. B. Fuller Co., 255 Eagle St., St. Paul 2, Minn. J

Circle 724 on Page 19

Ultrasonic Cleaners

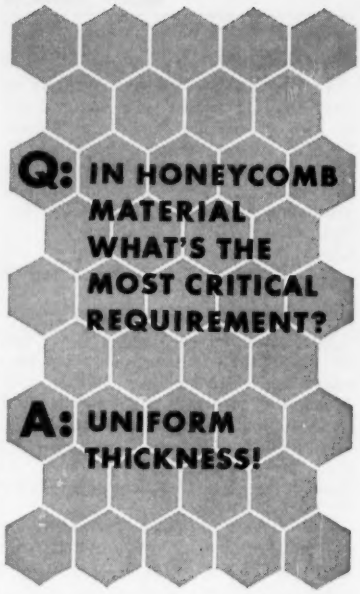
Line of ultrasonic cleaning equipment in a range of sizes is described and illustrated in two booklets. Their accessories, applications, and cleaning solutions are also covered. 4 and 6 pages. C. & E. Marshall Co., 1445 W. Jackson Blvd., Chicago 80, Ill. I

Circle 725 on Page 19

Transistor Choppers

Advantages of transistor choppers are compared with mechanical switches in Technical Bulletin J-256. Equivalent circuits are compared and application data are included. 4 pages. Texas Instruments Inc., Box 312, Dallas, Tex. P

Circle 726 on Page 19



In a recent nation wide survey of honeycomb section manufacturers by an independent research organization, 75% of the responders indicated that uniform thickness of the thin metal core material was the most important factor demanded of suppliers.

With modern equipment, such as Accu-Ray gauges, Sendzimir rolling mills and unique vertical annealing furnaces, Somers combines 50 years of pioneering in the thin metal field to answer this problem with Somers Thin-Strip®, produced exclusively by Somers Brass Co., Inc.

Somers also guarantees width tolerances as close as ± .001", a plus feature that assures the highest precision in honeycomb structures.

Whether your thin metal problem be in stainless, nickel or its alloys, copper or its alloys, 17-7, PH-15-7 MO or other honeycomb metals, you can depend on Somers ThinStrip® to meet your most critical specifications.

Write for Confidential Data Blank without cost or obligation.

FOR EXACTING STANDARDS ONLY

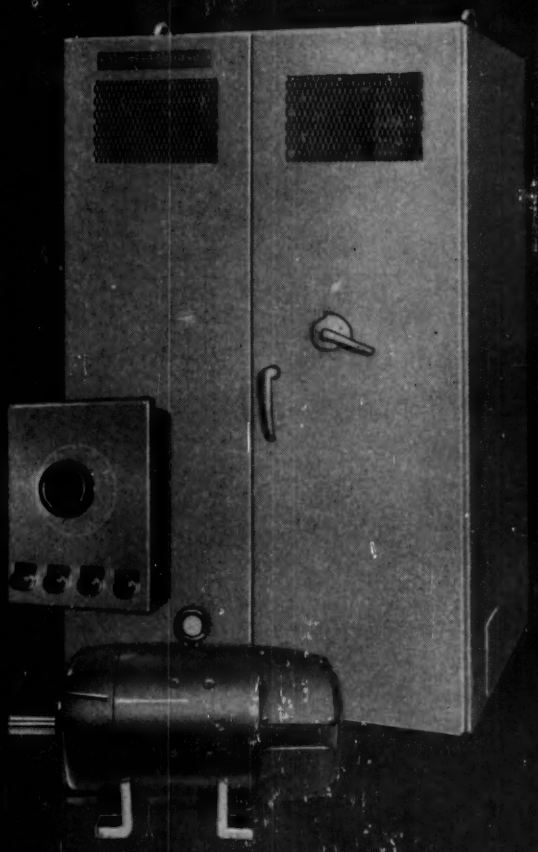
Somers

Somers Brass Company, Inc.

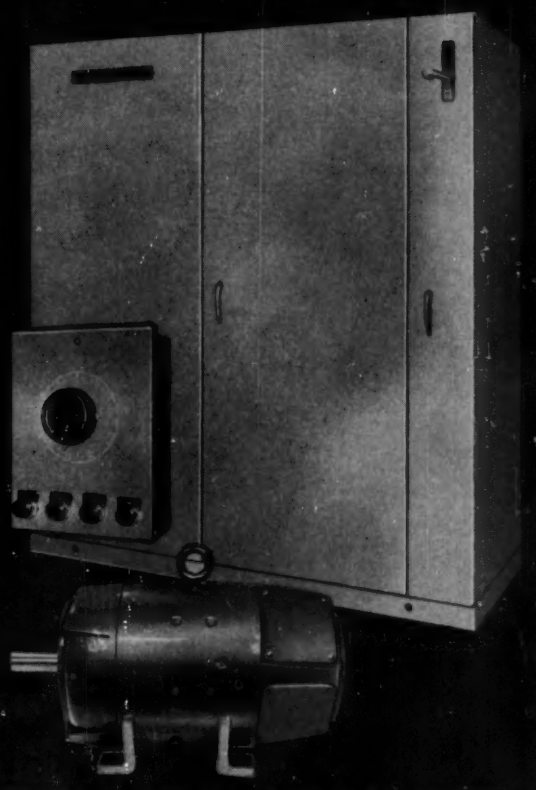
120 BALDWIN AVE. WATERBURY, CONN.

Circle 522 on Page 19

static-powered or motor-generator



Static-Powered model utilizes magnetic amplifier principle to replace conventional motor-generator set. There are no moving parts to weaken from wear. New forced-filtered air ventilation system reduces floor space required . . . simplifies installation.



Motor-Generator model, newly redesigned, features new cabinet, silicone-insulated d-c motor, new electronic regulators which simplify maintenance and positive-pressure ventilation for longer, trouble-free operating life.

WESTINGHOUSE HAS THE ADJUSTABLE-SPEED DRIVE YOU NEED!

When you need smooth, stepless adjustable speed, look to the complete line of new Westinghouse AV adjustable-speed drives . . . available in both static-powered and motor-generator models . . . whichever is best suited for your particular application.

Designed for use with motors 1 to 200 hp, Westinghouse AV adjustable-speed drives provide constant torque over an 8 to 1 speed range—10 to 1 with slight modification—and are also available with constant-hp speed ranges.

All Westinghouse AV adjustable-speed drives are completely pre-engineered, assembled and factory tested. Since all components used are service-proven Westinghouse products, you are assured of the benefits of sole responsibility from one single supplier.

Ask your nearby Westinghouse sales engineer to show you how and where new AV adjustable-speed drives can help you POWER-UP for profit and savings. Or, for complete product information, write Westinghouse Electric Corporation, 3 Gateway Center, Pittsburgh 19, Pennsylvania. J-22147

YOU CAN BE SURE... IF IT'S Westinghouse

WATCH WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS CBS TV FRIDAYS

Circle 523 on Page 19

PLUS
protection
against
overload

Maxitorq

overload release clutches

Designers and builders have found MAXITORQ Overload Release Clutches the ideal way to provide dependable protection against overload conditions.

Unlike such devices as shear pins, the MAXITORQ Overload Release Clutch requires no dis-assembly or replacement after functioning. Once the cause of overload is removed or corrected, the machine may be re-started at once. Furthermore, MAXITORQ Overload Release Clutches may be adjusted for pre-determined overload protection.

In addition, users enjoy the proved advantages of the MAXITORQ Floating Disc Clutch . . . smooth, positive engagement and release . . . "floating" neutral with no drag or heating . . . easy manual adjustment.

We will be glad to give you the benefit of our long and successful experience in clutch and brake design; the overload release clutches are only one of many advanced MAXITORQ developments in both manual and electrically operated applications. Ask for literature, or outline your problem . . . write Dept. MD.

THE CARLYLE JOHNSON MACHINE CO.
Manchester, Connecticut

2CJ58

HELPFUL LITERATURE

Aluminum Bearing Bars

Pocket-size booklet "The Technology of Bunting Bearing Aluminum Bars" provides informative data, tabular matter, and basic technical facts. Highlighted are line drawings of cutting tools for machining the bars. 12 pages. Bunting Brass & Bronze Co., 715-755 Spencer St., Toledo 1, Ohio. G

Circle 727 on Page 19

Nonreversing Starters

Line of nonreversing combination starters is offered with fusible or nonfusible motor circuit switches and with circuit breakers. Complete line is described in illustrated Bulletin ED-30. Sizes range through NEMA Size 4. Specifications are given for all models. 8 pages. Cutler-Hammer Inc., 328 N. 12th St., Milwaukee 1, Wis. K

Circle 728 on Page 19

Super Alloys

Chemical composition, physical constants, tables and charts of mechanical properties, isostress curves, and heat treatment and finishing data on vacuum induction melted Udimet 700 and 41 super alloys are offered in two technical bulletins. Both are for high temperature applications. 8 and 12 pages. Kelsey-Hayes Co., Metals Div., New Hartford, N. Y. D

Circle 729 on Page 19

Filter-Hose-Coupling

Descriptive literature in the form of a technical proposal covers the Triphane absolute 3-micron filter-base-coupling assembly for converting existing hydraulic service carts. Rated at 5000 psi, unit is offered in 6 to 30 gpm capacities. 6 pages. Aircraft Porous Media, Inc., Glen Cove, N. Y. D

Circle 730 on Page 19

Servo Motors

Performance ratings and dimensional drawings are given for both gearhead and nongearhead RBC-2407 stock servo motors in Bulletin MO-3.13. These reversible, low-inertia motors are used in remote positioning systems. 2 pages. National Pneumatic Co., Holtzer-Cabot Motor Div., 125 Amory St., Boston, Mass. B

Circle 731 on Page 19

Phenolic Molding Compounds

Molding Technical Release No. 36 lists chemical resistance of seven Bakelite phenolic molding compounds to acids, alkalies, solvents, and common mixtures. 12 pages. Union Carbide Plastics Co., 30 E. 42nd St., New York 17, N. Y. C

Circle 732 on Page 19

Time Delay Relays

Delay times from 50 milliseconds to 50 sec are covered by 18 standard electronic time delay relays shown in Bulletin 376-100. Factory preset and internally and externally adjustable units are offered. 8 pages. Master Specialties Co., 956 E. 108th St., Los Angeles 59, Calif. L

Circle 733 on Page 19

light weight die stock = lower cost metal forming

FIF
Fabricator of Industrial Formica Laminated Plastics

New Field Fabricating Service

Now fabricated parts delivered on Streamliner schedule—in 24 hours in some cases—from your local Fabricator of Industrial Formica laminated plastic. He serves you better with:

1. Faster delivery
2. Highest quality
3. 24-hr. delivery on standard Formica sheets and rods

Formica® S-52 die stock is half the weight of aluminum . . . gives you more metal forming surface per dollar. Has excellent machining qualities, can be fabricated faster and less costly than metal. Its strength/weight ratio is greater than steel, it has eight times the dent resistance of hard maple. Its smooth surface forms metal without surface irregularities.

S-52 is the perfect material for templates, stretch forming, hydro-press forms, metal spinning chucks, pattern boards . . . for drill and gluing jigs . . . for structural uses in aircraft, cars and boats. Your local Fabricator of Industrial Formica laminated plastic will fabricate your S-52 parts in record time. Send today for the name of your fabricator and free S-52 bulletin, form 872. Formica Corporation, a subsidiary of American Cyanamid, 4514 Spring Grove Ave., Cincinnati 32, Ohio.

FORMICA
Laminated Plastic

a product of CYANAMID

F1-2096

Circle 525 on Page 19

BEARING TIPS
by McGill

GUIDEROL® needle roller bearings save space and simplify design

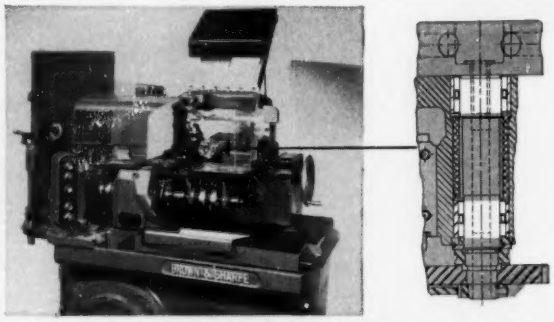
. . . especially where their greater capacity can reduce the size and cost of an adequate bearing housing. More and more designers are specifying McGill GUIDEROL bearings to carry heavier loads dependably with smaller bearings.

GUIDEROL bearings combine full type bearing capacity with center guided rollers that limit skewing and eliminate the possibility of binding under average misalignment. Especially suited to vertical mounting.

These precision heavy duty needle roller bearings are available with or without inner races in shaft sizes from ⅜" to 9¼". Specify the sealed series to keep out contamination and avoid relubrication.

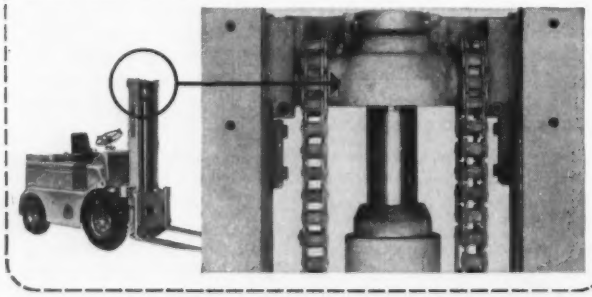
Minimum clearance, maximum load capacity retained in automatic screw machine

BROWN & SHARPE MFG. CO. replaced plain scraped bushings in the turrets of their No. 00 Automatic Screw Machines with McGill GUIDEROL bearings.
GUIDEROL bearings were selected to retain minimum clearance and maximum load capacity. In addition to meeting these requirements, the GUIDEROL eliminated production problems involved in the use of the scraped tapered bushings. The bearings support the turret during cutting and indexing operations. GUIDEROL design also satisfies the need for maintaining accurate alignment throughout long machine life.

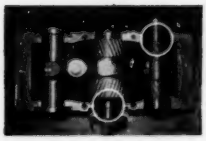


High capacity and compactness in lift truck chain cross-head rollers

GUIDEROL bearings support TOWMOTOR 6000 through 11,000 pound capacity lift truck payloads. They are used as chain crosshead roller bearings. Space requirements and the need for high capacity without the "walking" tendency of a straight needle roller bearing led to the selection of GUIDEROL bearings. GUIDEROL bearings have been rated very well in terms of length of life, maintenance and load carrying capacity in this application. Performance is rated excellent. The user reports reduced service requirements as compared with straight needle bearings formerly used.



Design simplified in mine machine transmission



Manufactured by the LONG Company, "PIGLOADER" coal loading machines feature full independent crawler control with a single motor. Application of GUIDEROL bearings on the tram clutch shaft is typical of other McGill bearing applications on the loader. GUIDEROL CT series bearings are used on the output end of the shaft to handle purely radial loads in small radial space. On the opposite end of the shaft, double row ball bearings handle combined thrust and radial loads. This combination eliminates the need for complicated adjustments. Use of a roller bearing, which has the same dimensions as the thrust bearing, accomplishes the design purpose with minimum machining variation in the transmission case. The GUIDEROL equipped tram transmissions allow each crawler to operate independently, a substantial design improvement.

engineered electrical products

McGILL®

precision needle roller bearings

SEND FOR CATALOG No. 52-A

MULTIROL — GUIDEROL — CAMROL

McGILL MANUFACTURING COMPANY, INC., BEARING DIV., 200 N. LAFAYETTE ST., VALPARAISO, INDIANA

Synchronous Motors

Precision hysteresis synchronous electric motors for use in tape transports, turntable drives, missile and aircraft instruments, and computer drum drives, and flow meters are subject of descriptive brochure. 4 pages. Telecomputing Corp., 915 N. Citrus Ave., Los Angeles 38, Calif. L

Circle 734 on Page 19

Ferrous Metallurgy Guide

A four-color 8½ x 11-in. version of the revised wall chart "Basic Guide to Ferrous Metallurgy" shows the principal characteristics of steel across the temperature range to 2900° F. Important working zones, such as for stress relieving, annealing, forging, etc., are shown. 2 pages. Tempil Corp., 132 W. 22nd St., New York 11, N. Y. D

Circle 735 on Page 19

Rotary Gear Pumps

Difficult-to-pump materials such as oils, greases, molten tin and lead, slurries, and paints are handled by Nitralloy rotary gear pumps. Capacities range up to 145 gpm. Bulletin 42 provides details. 4 pages. Northern Pump Co., Minneapolis 21, Minn. J

Circle 736 on Page 19

Pushbutton Pendant Switches

Watertight and corrosionproof pendant pushbutton switches in six and four-station models are enclosed in Hycar synthetic rubber compound. "X-ray" view of switch shows switch wells, water seals, and micro-type positive switches in position. 2 pages. Joy Mfg. Co., Electrical Products Div., 1201 Macklind Ave., St. Louis 10, Mo. F

Circle 737 on Page 19

Nylon Stock Shapes

Available sizes of Cadco nylon rod, plate, sheet, strip, and tubing are listed, and typical applications shown in brochure. Sizes range up to 10 ft x 15 in. rod, 10 ft x 12 in. plate, and 10 ft x 12 in. OD tubes. Molded massive shapes up to 25 lb are also offered. 8 pages. Cadillac Plastic & Chemical Co., 15111 Second Ave., Detroit 3, Mich. T

Circle 738 on Page 19

Porcelain Strainer

The porcelain strainer described in data sheet removes both coarse and fine solids before they enter chemical pumps, valves, or other process equipment. Lapp Insulator Co., Process Equipment Div., 110 Hall St., LeRoy, N. Y. N

Circle 739 on Page 19

Locks & Hinges

Bulletin presents ordering information and size tabulations on hinges for trucks, trailers, station wagons, and industrial uses. Supplementary bulletin illustrates and specifies a variety of compartment door locks and handles. 10 and 4 pages. Detroit Hinge Mfg. Co., 1632 W. Lafayette, Detroit 16, Mich. H

Circle 740 on Page 19

8423-SR

. . . *specify* STALWART!

MOLDED

EXTRUDED

SPLICED

DIE CUT

MACHINE CUT

HAND CUT

PRECISION GROUND

Channels or chicken pluckers . . . washers or weatherstrips . . . you name it and we'll make it! And we'll produce it to meet your most precise design specifications! Stalwart offers you a complete rubber parts *service* . . . Rubber Engineers develop your special compound from natural, synthetic or silicone rubbers . . . Laboratory Technicians pre-test actual performance . . . our own completely equipped Tooling Department produces the necessary extrusion dies . . . skilled Production Personnel operate the latest rubber machinery for maximum economy, dependable delivery . . . and *our* Quality Control Department protects *your* interests! This means you get higher quality at a lower cost . . . the result of nearly 40 years of fabricating experience! To solve tough rubber parts problems . . . cut assembly costs, *specify Stalwart.*

Write today for complete information.
Ask for your copy of Stalwart Catalog SR-59.

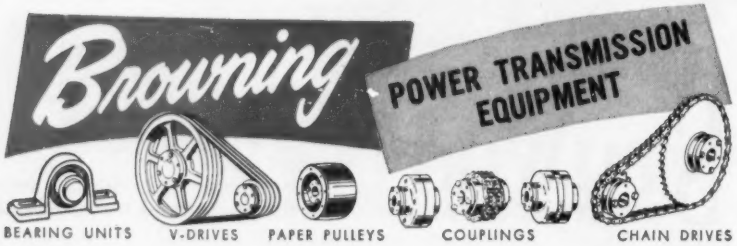
STALWART RUBBER COMPANY

180 NORTHFIELD ROAD • BEDFORD, OHIO
PLANTS in BEDFORD, OHIO and JASPER, GEORGIA

Circle 527 on Page 19

Feature by feature, compare this new Browning bearing unit with any other. It is the only heavy duty roller bearing with eccentric locking collar, ensuring firm grip to the shaft. It is designed with housing of *unbreakable malleable*, which provides extra strength, permits more compact design, lighter weight. And it incorporates a new tapered roller arrangement specially designed by Timken for Browning, to compensate automatically for normal misalignments. Labyrinth seals retain the lubricant, shut out dirt; elongated bolt holes provide wide adjustment and maximum interchange.

Browning distributors, coast-to-coast, stock these new tapered roller bearing units in 24 shaft sizes from 1 3/16" to 4"; completely assembled, ready for use. Ask your distributor for full information and new descriptive bulletin BU-102A. Or write **Browning Manufacturing Company, Maysville, Kentucky.**



HELPFUL LITERATURE

Magnetic Clutches

Technical booklet describes "Magnetic Clutches and Their Applications." It completely details design and applications, and technical and testing specifications. Clutches and brakes are widely used in control applications and vary the coupling between two shafts by means of low-power signals. 18 pages. PIC Design Corp., 477 Atlantic Ave., East Rockaway, L. I., N. Y. D

Circle 741 on Page 19

Tape Recorder-Reproducer

Physical and operating features of the Type 5-752 magnetic tape recorder/reproducer are described in Bulletin 1576B. System accommodates seven different types of recording and reproducing amplifiers for analog, FM, or PDM modes of operation. Specifications folder is included. 6 pages each. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. L

Circle 742 on Page 19

Fluid Power Equipment

Pumps, motors, transmissions, servo components, cylinders, and valves are among the fluid power equipment detailed in condensed Catalog 10051. Devices for use in all types of industries are shown, and their performance capabilities are listed. Units are available for pressure services ranging in excess of 3500 psi. 16 pages. Oilgear Co., 1570Q W. Pierce St., Milwaukee 4, Wis. K

Circle 743 on Page 19

Rubber Products

The 1959 Catalog is divided into production facilities, molded rubber, bonded rubber-to-metal, vibration mount, O-ring and gasket, and diaphragm and extrusion sections. Details of standard rubber products produced as well as engineering and production facilities available for engineered products are given. Natural and synthetic rubber products are covered. Stoner Rubber Co., 10792 Knott Ave., Anaheim, Calif. L

Circle 744 on Page 19

Data Processing Equipment

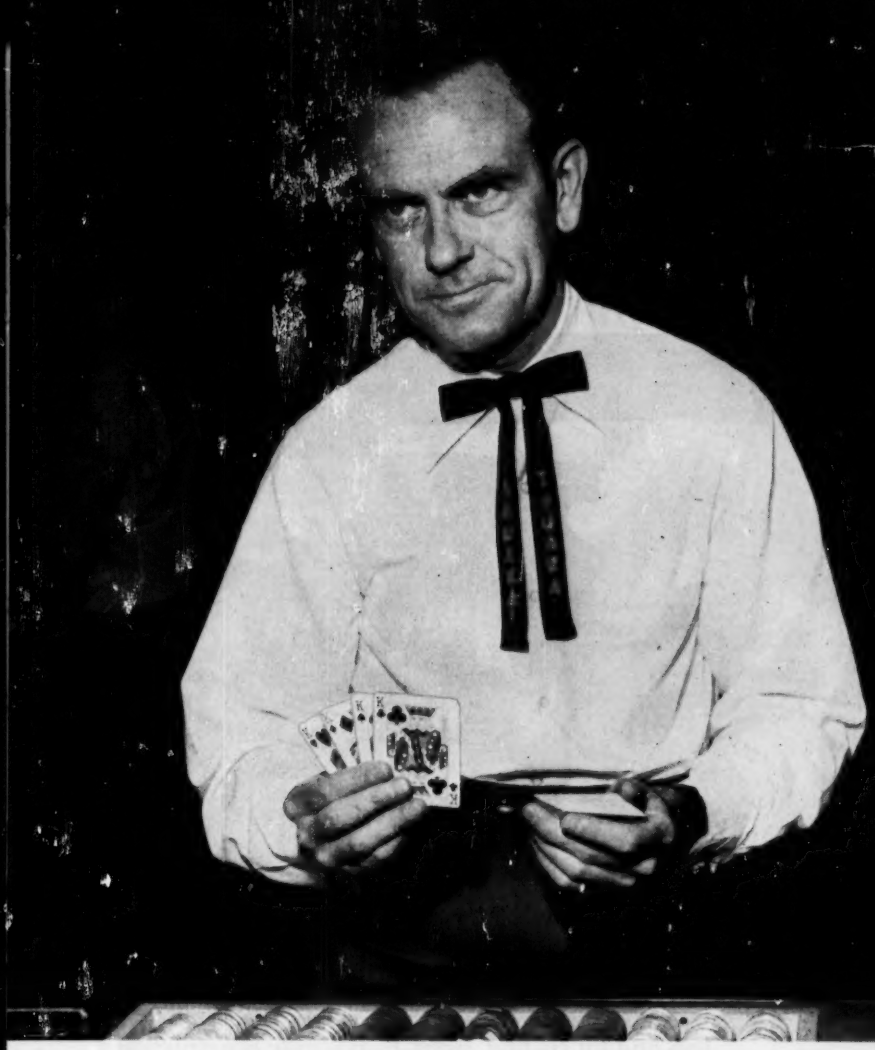
Data processing equipment, including digital data processing, and analog and digital computing systems are subject of Preliminary Technical Publication N-07 (1). It explains types of inputs, input switching, output devices, and modes of operation for electric power, petrochemical, aeronautic, and agricultural uses. 48 pages. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa. E

Circle 745 on Page 19

Airless Spraying

Advantages of both heat and hydraulic pressure are combined in the Nordson Airless system for spraying paints, varnishes, lacquers, adhesives, and dyes. The idea behind the system, how it works, and the spraying equipment are discussed in folder. 8 pages. Nordson Corp., Amherst, Ohio. G

Circle 746 on Page 19



The gambler has one thing in common with you

Photo courtesy of Sahara Hotel, Las Vegas, Nevada

... he, too, relies upon the mathematical Law of Probability. For example, what is the probability that the first four cards dealt from a well-shuffled deck will be kings? As each card is dealt and is a king, the odds run like this: First card — 4 in 52; 2nd — 3 in 51; 3rd — 2 in 50; 4th — 1 in 49. The probability thus is:

$$\frac{4}{52} \times \frac{3}{51} \times \frac{2}{50} \times \frac{1}{49} = \frac{1}{270{,}725}$$

In the same context, what index of Reliability can be predicted for a mechanism with 100 parts, each of which will function perfectly 99 times out of 100? The probability is that the mechanism (if not Electrolized) will fail six times out of ten.

The gambler is content to accept the generous rewards bestowed on him by the Law of Probability. The engineer is rewarded when he uses the Law of Probability to improve the Reliability of his product.

Electrolizing has made outstanding contributions to the reliability of mechanisms in every field where the reduction of friction and the resistance of metal to wear, seizure, and corrosion are important. This proved process commonly increases wear part life 200% to 800%. It provides precision, uncompromising quality control and Reliability at a practical cost.

You can find out at no cost and without obligation if Electrolizing is the answer to your problem. Simply send us a few sample parts, a covering letter outlining your problem, and a drawing marked to indicate the critical areas. The parts will be Electrolized at no charge and returned to you for testing. (Cutting tools, dies, fixtures, and molds are excluded from this offer.)

If you have any questions, write or phone for a prompt reply.

THE Electrolizing COMPANY

DIVISION OF ADVANCE INDUSTRIES, INC.
1505 East End Avenue, Chicago Heights 5, Illinois

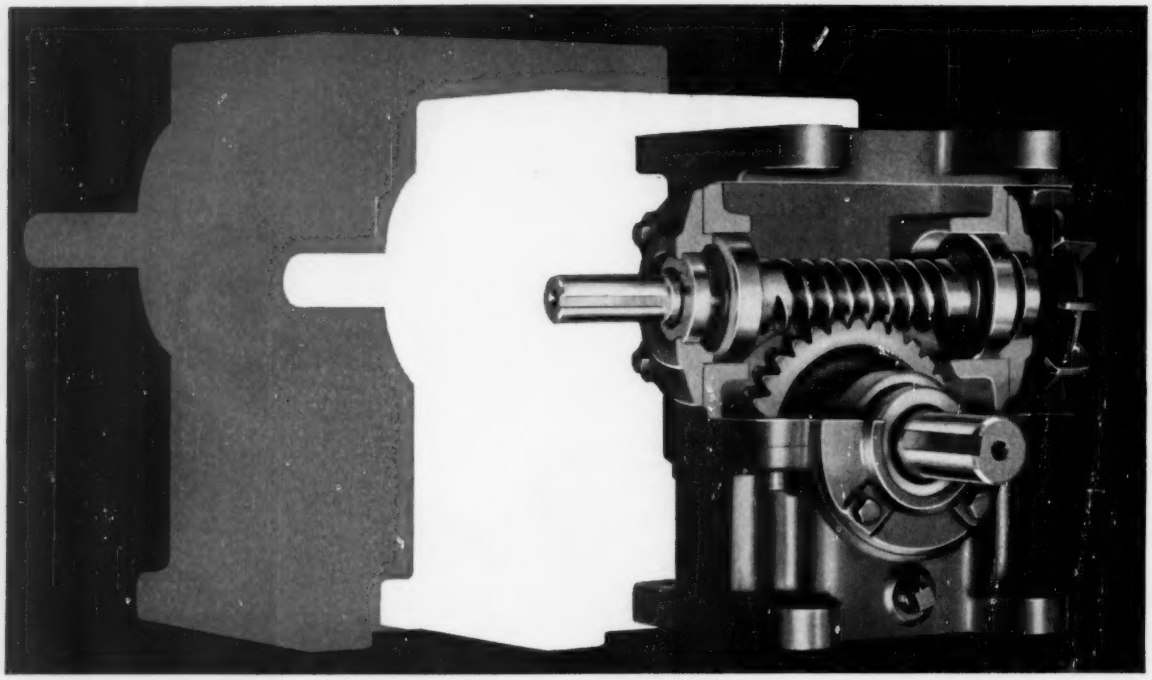
OTHER PLANTS AT:

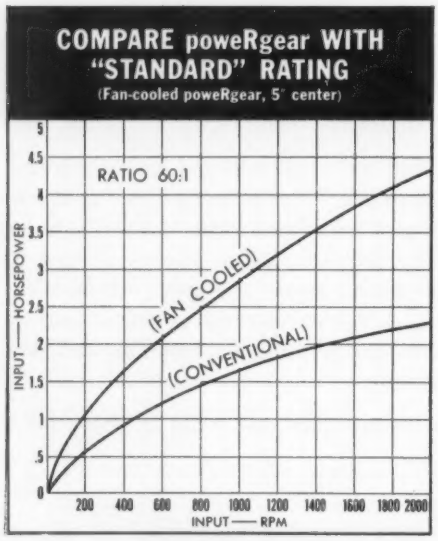
Providence 1, R.I. — 148 W. River Street
Cleveland 12, Ohio — 1325 E. 152nd Street
Los Angeles 11, Calif. — 1947 Hooper Avenue

Circle 529 on Page 15

Based on performance, Morse Eberhardt-Denver Speed Reducers give you:

MORE CAPACITY FOR YOUR MONEY





These curves compare a 5 inch center distance poweRgear with a 5 inch center conventional non-fan cooled heavy duty unit. Because of its fan-cooled design and extra-heavy construction, a Morse E-D poweRgear Speed Reducer easily exceeds "standard" ratings . . . delivers more horsepower per dollar!

Fan and fin cooling, extra-heavy-duty construction let poweRgear® do *more* work in a given size; you save space and weight, often trim initial costs

You get *more* than "rule-of-thumb" ratings call for, when you specify stock Morse Eberhardt-Denver poweRgear Speed Reducers. You pick and pay for the capacity you *need* . . . get it, as set realistically by exhaustive laboratory tests and critical on-the-job ratings.

Fan-and-fin cooling holds operating temperature down, sends rated life up on a poweRgear reducer. Its universal design permits mounting in bottom, top or vertical positions and includes extra-heavy housing, shafts and bearings. Result: you can specify a smaller, lighter, more compact unit to do your job . . . get *more* capacity for every reducer dollar.

There's a Morse E-D poweRgear reducer for *every* job: fractional to 40 H.P.; ratios from 5:1 to 3600:1; center distances from 2″ to 7″. Other Morse E-D speed reducers: conveyor drives; miter boxes; helical reducers; gear motors; worm and gear sets.

FOR MORE FACTS, call your Morse distributor today (see the Yellow Pages under "Power Transmission.") Or write: Morse Chain Company, Dept. 6-129, Ithaca, N. Y. Export Sales: Borg-Warner Intl., Chicago 3, Ill. In Canada: Morse Chain of Canada, Ltd., Simcoe, Ont.

MORSE MORSE B-W *Trademark

A BORG-WARNER INDUSTRY

ONLY MORSE OFFERS ALL 4: Chain and "Timing"® Belt Drives; Speed Reducers, Couplings, Clutches

Testing Facilities

Environmental, qualification, and reliability testing facilities of company for testing electronic, pneumatic, hydraulic, mechanical, and electromechanical components to commercial, aircraft, and military specs are shown in folder. Test stands can apply loads up to 125,000 lb. 4 pages. Horkey-Moore Associates, 24660 Crenshaw Blvd., Torrance, Calif. L

Circle 747 on Page 19

Gold Spray Finishes

Bronzeless Gold spray finishes discussed in brochure are intended for use on plastics, metals, glass, and paper. They are nontarnishing, nongelling, hard, and easy to apply. Color chips are displayed in the booklet. 8 pages. Bee Chemical Co., Logo Div., 12933 S. Stony Island Ave., Chicago 33, Ill. I

Circle 748 on Page 19

Electroforming

"Tech Notes from Allied" is title of technical news letter which will feature news and technical developments in the field of electroforming. It will be sent "on occasion" to those interested in this field. 1 page. Allied Record Mfg. Co., 6916 Santa Monica Blvd., Los Angeles 38, Calif. L

Circle 749 on Page 19

Baking Finish

Uni-Clad baking finish for dip or spray application on ferrous and nonferrous metals provides a tough, chemical resistant coating that is unaffected by most solvents. Full information is given in bulletin. 4 pages. Universal Paint & Varnish Inc., Bedford, Ohio. G

Circle 750 on Page 19

Liquid Epoxy Resin

Technical Information Bulletin K-2967 gives complete information on properties and uses of Kopoxite 159. This versatile liquid epoxy resin is suited as a principal component of castings, potting and encapsulating compounds, tooling resins, laminates, and adhesives. 20 pages. Koppers Co., Chemicals & Dyestuffs Div., Development Dept., Pittsburgh 19, Pa. F

Circle 751 on Page 19

Electrical Connectors

Four types of miniature multicontact connectors which meet Military specifications are described in Form BB. They are vibration and moisture resistant, and interchangeable with other miniature types. 2 pages. Burndy Corp., H. H. Buggie Div., Box 817, Toledo 1, Ohio. G

Circle 752 on Page 19

Data Log

The Datex-Monroe Data/Log is a series of digital printing and calculating machines with modifications to meet a wide range of data recording needs. Specifications and application information are given on six machines in this series in Bulletin 200. 4 pages. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif. L

Circle 753 on Page 19

This stepping motor, when suitably pulsed, has a torque output of 1 inch-ounce, in steps that are never more, never less than 18°. Each one is produced by a half cycle or a current reversal. Consequently it is very useful for converting electrical numbers to mechanical numbers, and has been sold for this purpose for some time (the Sigma "Cyclonome"®).

In the trick mirror is a servo motor which stops on command with perfect obedience, because it stops every little while anyway, delivering torque in 18° quanta. The 20-tooth ratchet sensation is produced by a fiercely discontinuous permanent magnet field, which develops going and stopping torques of 1 inch-ounce.

So, here is a positioning servo motor which is synchronous and has a mechanical time constant of ¼ cycle. Effective ratio of torque to inertia, with regard to coasting, is *infinite*—as long as these parameters are respected:

inertia (gram-cm²) x (steps/sec.)² ≦ 180,000, and
steps/second ≦ 300, assuming direct drive to mechanical load.
(Otherwise, you have a synchronous motor of unspecified nature.)

Since any reduction ratio is squareable (we wish it were cubable) a ratio of 10:1 permits an inertia of 200 gram-cm² to be driven at three-hundred 1.8° steps per second. Useful torque is then 700 gram-cm. Think of it—*6 inch-pounds* per second, for only 10 or 15 watts. While there is a relation between power and speed, there is *no relation between torque and speed*. Torque is proportional to input current (up to saturation), speed to input frequency.

If you will write on your letterhead, you will receive an engineering bulletin describing the simple Cyclonome discussed above, as well as the reversible model.

Merry Christmas - Art Dept.

SIGMA INSTRUMENTS, INC.
89 Pearl Street, So. Braintree 85, Massachusetts
An Affiliate of The Fisher-Pierce Co. (since 1939)

Circle 531 on Page 19

COST-CUTTING PRODUCTION TEAM

The two-way answer to assembly problems

Assembly problems are a designer's problem, too. Milford offers tubular rivets made to high quality standards to assure a better finished product... a wide line of Automatic Riveters that assemble your "brainchild" with care, precision and economy.

For the answers to assembly problems ... *get in touch with Milford first.*

THE MILFORD RIVET & MACHINE CO.

MILFORD, CONNECTICUT • HATBORO, PENNA.
ELYRIA, OHIO • AURORA, ILL. • NORWALK, CALIF.

Circle 532 on Page 19

HELPFUL LITERATURE

Drawing Reproduction

How Dinoflex engineering reproduction drawing films are used to advantage in reproducing engineering layouts, plans, maps, drawings, and other work is explained in illustrated folder. Matte surface types are available which will accept pencil or ink revisions. 4 pages. Di-Noc Chemical Arts, Inc., 1700 London Rd., Cleveland 12, Ohio. G

Circle 754 on Page 19

Pulse Transformers

Catalog No. 202 is also an application manual. It contains definitions, ordering information, theory of operation, and other data on miniature and subminiature pulse, pulse modulation, and magnetron transformers. 24 pages. Pulse Engineering, Inc., 560 Robert Ave., Santa Clara, Calif. L

Circle 755 on Page 19

Pipe & Electrical Markers

Self-adhesive plastic labels for permanent identification of pipes, cables, conductors, conduit, controls, panelboards, switchboards, tanks, and other lines of equipment are listed and described in Bulletin 803. Price and ordering information is included. 4 pages. Seton Name Plate Co., 431 W. Rock Ave., New Haven 15, Conn. B

Circle 756 on Page 19

Precision Rotary Switch

Conforming to Military specs, WP-2 precision rotary switch provides pulses, spaced as required and for almost any duration, when running at a shaft speed of 5 rpm. This compact control is described in illustrated data sheet. 1 page. Waters Mfg., Inc., Wayland, Mass. B

Circle 757 on Page 19

Transducer

The Hi-Ac-Tran Model 106 transducer is designed for adapting new or existing pneumatic equipment to electronic control. It provides accurate linear conversion of a varying dc signal to a pneumatic signal. Details are given in Bulletin E-106. Associated Control Equipment Inc., 853 Fourth Ave., Coraopolis, Pa. F

Circle 758 on Page 19

Roller Bearings

Data on the new HJ Series roller bearings with bore sizes from ¾ to 4 in. comprise Catalog 359. Interchangeable with standard needle bearings, they operate at speeds higher than conventional roller bearings and have greater load capacities. 6 pages. Torrington Co., Torrington, Conn. B

Circle 759 on Page 19

Stud Welding Fasteners

The stud welding system is described and specifications for stud welding fasteners are presented in illustrated handbook. Each specification page has dimensions, typical use data, and ordering and specifying information. 48 pages. Request on company letterhead from KSM Products, Inc., Merchantville 8, N. J. D

NO LUBRICATION
NO MAINTENANCE
NO WEARING PARTS

Future maintenance costs and shutdowns are eliminated when you install Thomas Flexible Couplings. These all-metal couplings are open for inspection while running.

They will protect your equipment and extend the life of your machines.

Properly installed and operated within rated conditions, Thomas Flexible Couplings should last a lifetime.

UNDER LOAD and MISALIGNMENT ONLY THOMAS FLEXIBLE COUPLINGS OFFER ALL THESE ADVANTAGES:

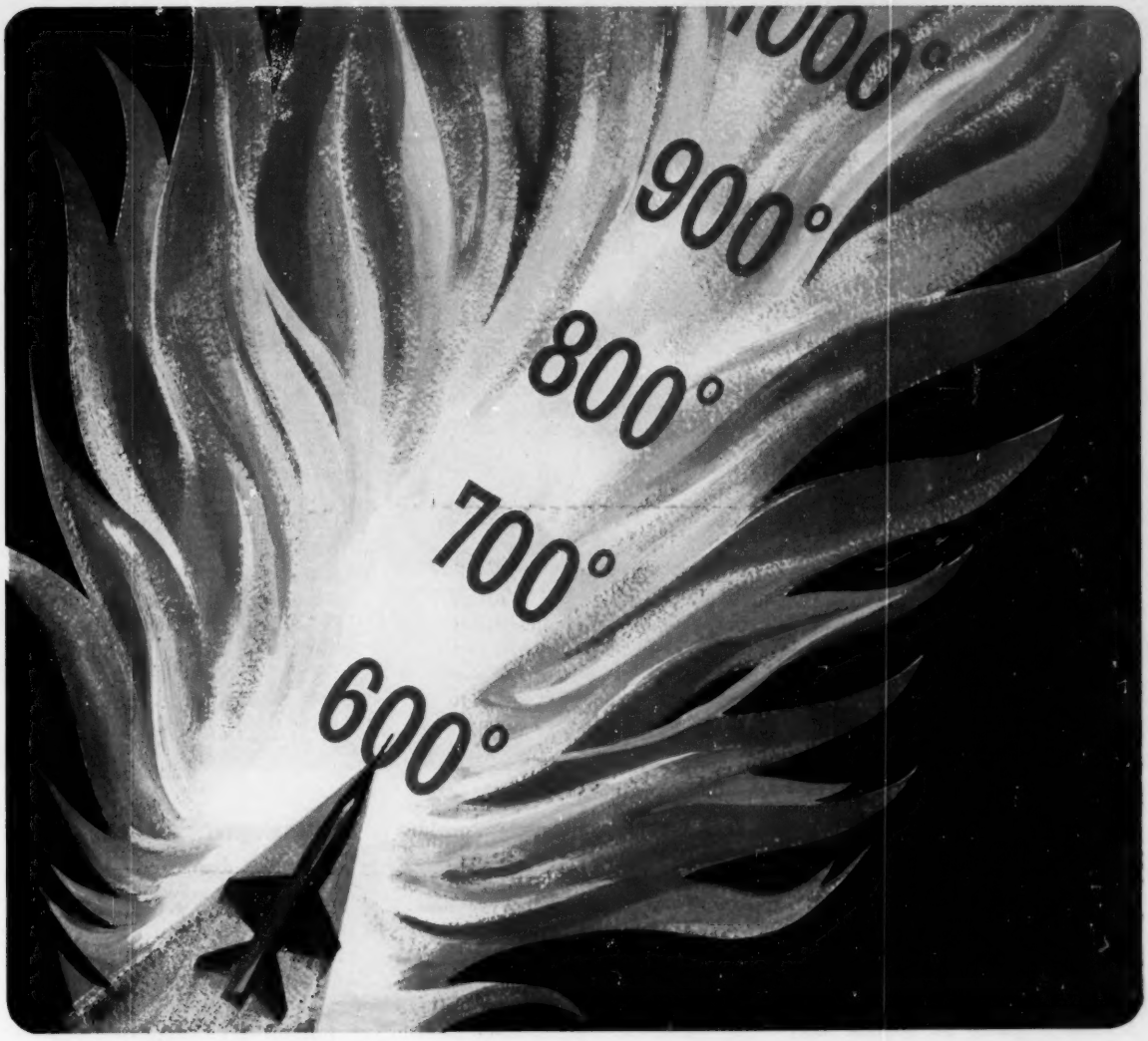
- Freedom from Backlash
- Torsional Rigidity
- Free End Float
- Smooth Continuous Drive with Constant Rotational Velocity
- Visual Inspection While in Operation
- Original Balance for Life
- No Lubrication
- No Wearing Parts
- No Maintenance

Write for Engineering Catalog

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

Circle 533 on Page 19

Experience—*the added alloy in* **Allegheny Stainless**



Easy-to-form metals with high strength up to 1000 F

AM 350 and AM 355, precipitation hardening stainless steels by Allegheny Ludlum have many advantages for designers of missiles and supersonic aircraft in solving space age problems.

Among their many desirable properties, AM 350 and AM 355 combine high hardness and strength and stability up to 1000 F and yet possess good ductility. They are easy to form in the annealed condition.

They can be spun, drawn, formed, machined and brazed or welded using normal stainless steel procedures.

Both steels have excellent corrosion resistance and good resistance to stress corrosion and oxidation at higher strength levels.

AM 350 is available commercially in sheet, strip, foil, small bars and wire. AM 355, best suited for heavier sections, is available commercially in forgings, forging billets, plates, bars, wire, sheet and strip.

For further information, see your A-L sales engineer or write for the new technical booklet, "AM 350 and AM 355." **Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.**

ALLEGHENY LUDLUM

EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

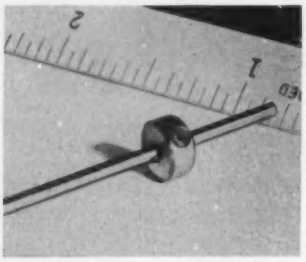
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Miniature Shaft Collars

for thrust take-up, positioning, and locking

Tiny alloy-steel collars for shafts 1/16 and 3/32 in. diam are used in taking up thrust, for locking, spacing, and positioning shafts, and for many other mechanical miniaturization applications in the electronics, instrument, and machinery fields. Collars have Unbrako hex socket set screws to hold them in place with great clamping force. Set screws are supplied with plain



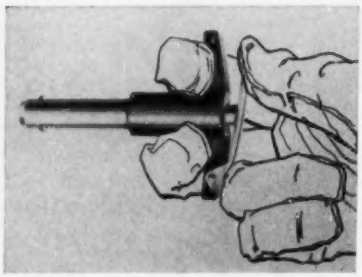
cup point as standard, and with other points and Nylok self-locking feature available as options. Bore size is stamped on face of collars. **Standard Pressed Steel Co.**, Jenkintown, Pa. C

Circle 760 on Page 19

Quick-Release Fasteners

now incorporate spring-action lever

Series 5440 single-acting Pip Pins incorporate a spring-action lever, permitting heavily gloved or mittened operator to seize and instantly release Squeeze Grip pin from its application. Pressure on lever pushes release button, moving spindle to allow steel balls to recede flush with outer surface of pin body for fast insertion or removal of pin. Pin cannot be released accidently. Squeeze Grip pins are available in T and L-handle styles



in diameters from 1/4 through 7/16 in. **Aviation Developments Inc.**, 210 S. Victory Blvd., Burbank, Calif. L

Circle 761 on Page 19

Idler Pulley

for use in dial-type indicators

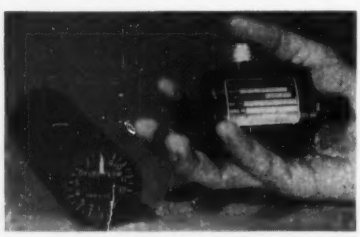
Low-cost idler pulleys are molded from polystyrene. They are designed for use in radios, tuners, and other equipment using dial-type indicators. Pulleys are available in 3/8, 1/2, and 5/8-in. OD sizes. Special sizes and materials are furnished on request. **Richco Plastics Co.**, 4445 W. Fullerton Ave., Chicago 39, Ill. I

Circle 762 on Page 19

Mass Flowmeter

miniature unit is for small aircraft

Miniature mass-flowmeter system features a transmitter (shown in hand) that incorporates only two moving parts. Consisting of a flowmeter transmitter and flow-rate indicator, system provides small business and commercial aircraft, small jets, and helicopters with a practical means of measuring fuel-flow rate by mass rather than volume. Readings are not affected by normal variations in fuel temperature, pressure, density, and viscosity. Total weight of system is approximately 2 lb. Normal range involves flow rates to 1200 pph. System provides its own frequency regulation for transmitter. Power requirement is 115 v, 400 cycles. Transmitter withstands severe vibration and other mechanical abuse, and operates within temperature range of −65 to +250 F. **General Electric Co.**, Schenectady 5, N. Y. C

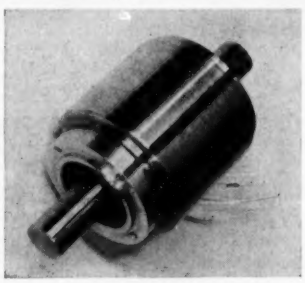


Circle 763 on Page 19

Electromagnetic Clutch

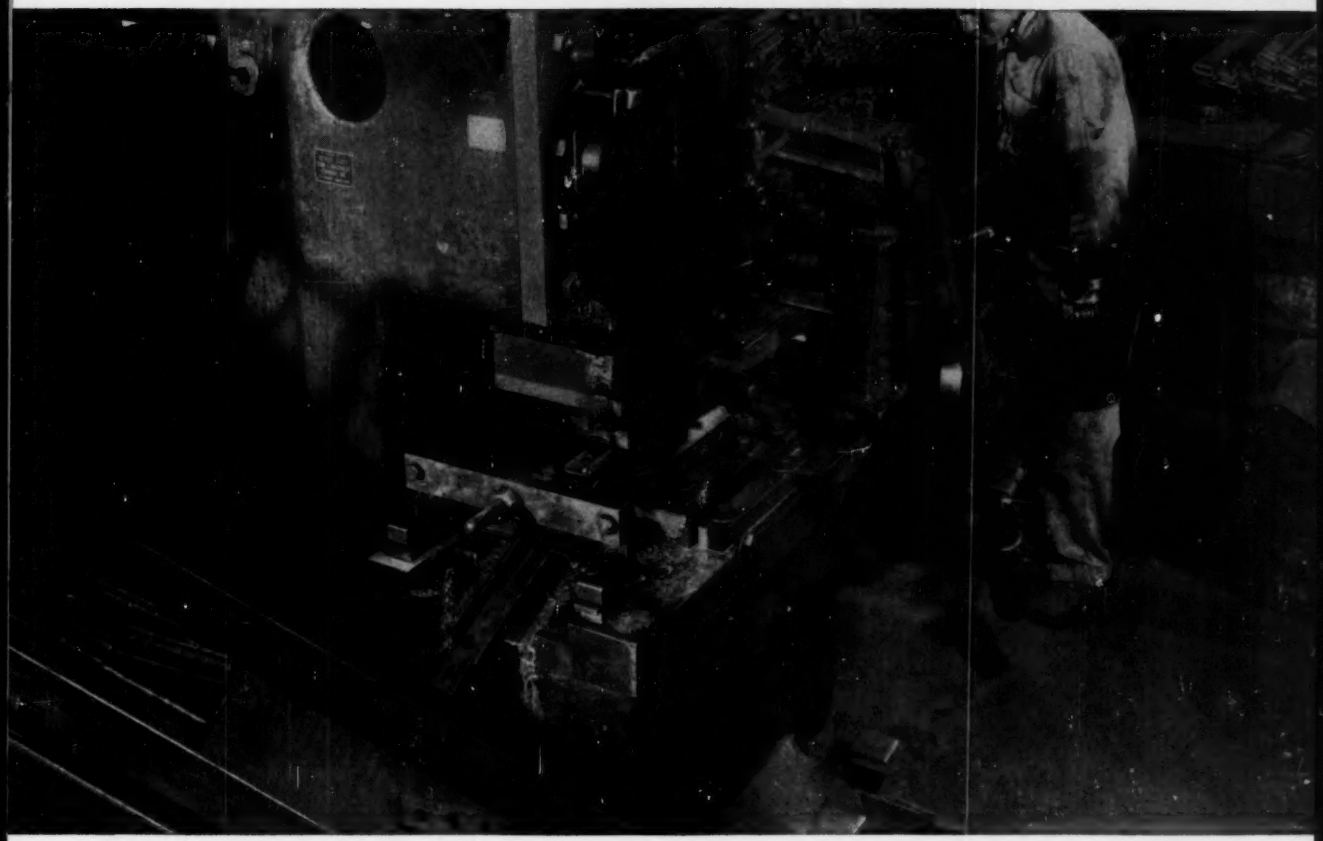
has 2-in. diam and 2-in. long body

High torque capacity and small size are features of electromagnetic, stationary-field jaw clutch. Diameter

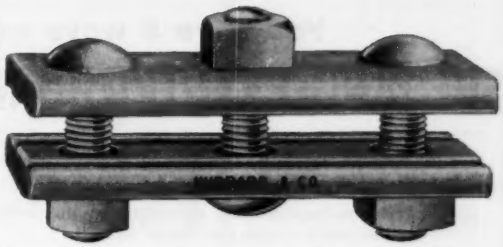


and length are 2 in. Power consumption of 10 w yields torque of 12 lb-ft. Engagement speeds of several hundred revolutions per minute are possible. Tapped holes and pilot are provided for mounting to bracket or wall. Ball bearings support 1/2-in. diam clutch shafts, making other support of adjacent shafts unnecessary. Clutch can be supplied in other configurations, such as integral couplings. Dc power supply is offered standard in 24 v,

STEEL SHAPED TO CUT COSTS AND IMPROVE PRODUCTS



One automatic operation punches three holes and shears off the part from a USS Hot-Rolled Special Section. No machining necessary.



Hubbard pole line hardware made from USS Special Sections.

Pole line hardware • one punch • made from USS Special Sections

Hubbard and Company is one of the largest pole line hardware manufacturers in this country. They turn out guy clamps, cable suspension clamps and lashing clamps by the thousands. To keep production costs low, they use USS Special Sections already rolled to the proper cross section for the finished piece.

Many items can be punched and sheared in one automatic operation so that there is no machining and very little scrap. Parts can then be galvanized, bolts inserted and the job completed.

How USS Special Sections can reduce your costs. If you have an irregular steel part that must be produced in quantity at low cost, let us check your drawings. Many times a complex and costly assembly can be replaced by the use of one USS Hot-Rolled Special Section. Designs are unlimited. Write for our new book showing many intricate shapes already being produced. United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

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USS

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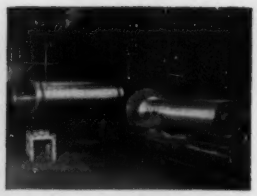
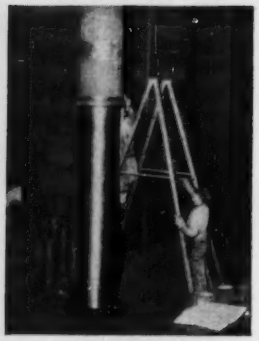
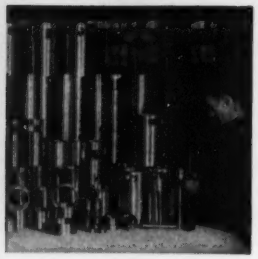
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Export Company

United States Steel

Please direct inquiries to advertiser, mentioning MACHINE DESIGN







You save 5 ways with

SHENANGO CENTRIFUGAL CASTINGS

By using Shenango centrifugal castings for essentially symmetrical parts, you will gain considerable savings because:

1. **The Shenango process automatically eliminates hidden defects in the metal . . . insures fewer rejects.**
2. **No patterns required . . . an important saving, particularly on special or small quantity runs.**
3. **Finer, more uniform grain structure means smoother, faster machining, better control, and a higher rate of completion.**
4. **With Shenango centrifugal method control, there's less excess metal to be machined away, less metal to buy and ship!**
5. **Because of their homogeneous, pressure-dense qualities, Shenango centrifugal castings are stronger, have better wear resistance and require less frequent replacement. Maintenance cost is cut!**

Check with Shenango on centrifugally cast parts for your needs —large or small castings . . . rough, semi-finished or precision-machined . . . ferrous or non-ferrous. They'll cost you less in the long run. For bulletins, write to: *Centrifugally Cast Products Division,* The Shenango Furnace Company, Dover, Ohio.

SHENANGO CENTRIFUGAL CASTINGS

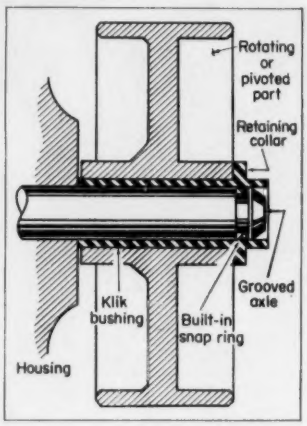
COPPER, TIN, LEAD, ZINC BRONZES • ALUMINUM AND MANGANESE BRONZES
MONEL METAL • NI-RESIST • MEEHANITE METAL • ALLOY IRONS

but clutches can be supplied in other voltages. **Dayton Superior Products Co.**, 420 Stonemill Rd., Dayton, Ohio. G

Circle 764 on Page 19

Plastic Bushing

for assembling parts which rotate, pivot, or rock



Klik rapid-locking bushing is suitable for use in appliances, toys, office machines, automotive products, and instruments where low cost, high efficiency, and simple assembly are important considerations. A simplified device for assembling parts which rotate, pivot, or rock, bushing is one-piece, low-friction, corrosionproof plastic. As device is inserted into moving part, it automatically snaps onto axle, eliminating need for locking devices. Bushing combines journal and thrust collar into one single unit. Collar holds moving part firmly in place on bushing and completely eliminates need for separate holding device. Built-in snap ring found on interior surface of bushing engages groove of axle and holds with such force that assembly is virtually permanent. Bushing is available in a range of sizes from 0.205 to 0.5 in. OD. **M-H Standard Corp.**, 517 Communipaw Ave., Jersey City 4, N. J. D

Circle 765 on Page 19

Miniature Switch

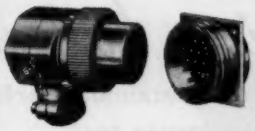
for low-power and electronic circuits

Type MA-12-L miniature switch provides multicircuit control, panel

RELIABLE MULTI-PURPOSE "K" SERIES

cam-8-k

K STANDARD

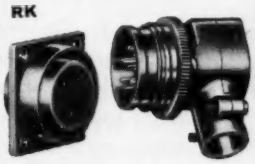


FOR AIRCRAFT, ELECTRONIC, INSTRUMENT, MILITARY, MISSILE, INDUSTRIAL AND COMMERCIAL APPLICATIONS Standard K and RK ..in straight and angle 90° plugs with wall mounting receptacles. Conduit and clamp entry types. 1 to 110 contacts in 250 different insert arrangements. 10, 15, 30, 40, 60, 80, 115 and 200 amp. silver plated brass on copper contacts. High quality phenolic, melamine, and formica insulators. Cadmium-plated aluminum alloy shells. Flashover voltages: 110 to 5000V, 60 cps ac rms.

KH-RKH

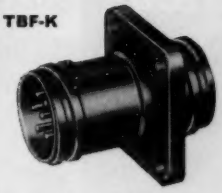
FOR USE UNDER CRITICAL PRESSURE AND LEAKAGE CONDITIONS—Hermetically sealed plugs with steel shells, steel contacts, and Canseal glass insulators for true hermetic sealing. Electro tin plating over cadmium plate over copper flash provides highly receptive surface for soldering and corrosion resistance.

RK



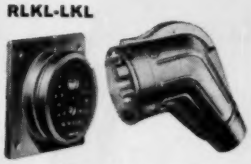
FOR FLUSH OR SEMI-FLUSH MOUNTING—Cannon RK Plug assemblies are equipped with an external threaded coupling nut which is the reverse of the standard K Series. Note: RK will mate only with RK's.

TBF-K



FOR CARRYING CIRCUITS THROUGH BULKHEADS Cannon TBF-K Bulkhead Plugs feature a double-faced construction allowing mating at both ends. Pin inserts. Single piece shell.

RLKL-LKL



FOR TV AND OTHER PANEL SWITCHING OPERATIONS—Quick connect and disconnect RLKL Plugs are designed for one-hand fast disconnect use on TV station program switching panels and similar type operations. Feature a quick coupling means. Latch-lock secures plug to mated fitting (RLKL receptacle). Thumb pressure releases it.

FW-K FWR-K

FOR OPEN FLAME PROTECTION AGAINST HIGH TEMPERATURES—Cannon K Firewall Plugs are available in straight and angle 90° shell types. Wall mounting receptacles also available. Phenolic or fireproof inserts of glass-filled materials. Crimp type contacts. Cannon originated the firewall connector and continues to be the leader in this important field.

SK-M7-21C

FOR USE IN TELEPHONE "BEEPER" AND SIMILAR APPLICATIONS—Widely used on telephone recording units known as "beepers." Adaptable for other similar applications.

K ACCESSORIES—Cannon K Series Accessories include Straight and Angle 90° Junction Shells, Dust Caps, Bonding Rings, Gland Nuts, Clamps, and Dummy Receptacles to hold and protect plugs when not in use.

Cannon has available a wide variety of other Plug designs FOR EVERY CONCEIVABLE APPLICATION...including aircraft and electronic Plugs conforming to Specification MIL-C-5015D; Unit-Plug-In Rack/Panel and Modular; Audio and Low-Level Circuit Plugs; Miniature and Sub-Miniatures; Coaxial RF Series Plugs, Printed Circuit Plugs; GM Plugs and Cannon Plug/Harness Systems: "Kwik-Term" Terminals and DC Solenoids.

FOR ADDITIONAL INFORMATION on the typical designs illustrated...other configurations for your specific applications...or the design, engineering and manufacture to your special needs...write to **Cannon Electric Company**—3208 Humboldt Street, Los Angeles 31, California. Please refer to Dept. 185.

LARGEST FACILITY IN THE WORLD FOR PLUG RESEARCH-DEVELOPMENT-MANUFACTURE

CANNON PLUGS

Factories in Los Angeles, Santa Ana Salem, Toronto London, Paris, Melbourne, and Tokyo. Distributors and Representatives in the Principal Cities of the World.

For a money-saving balance

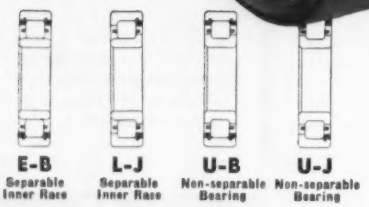
between maximum performance and moderate cost . . .

ROLLWAY
Tru-Rol®
BEARINGS

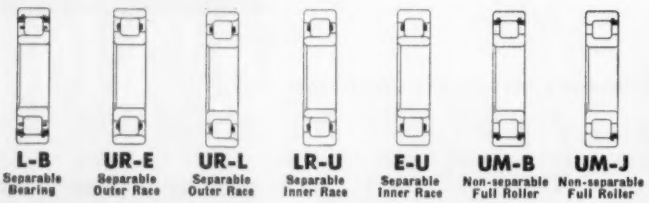
Give you more for your bearing dollar

For those hundreds of in-between applications where performance requirements are more exacting than those provided by the ordinary commercial bearing, but where maximum precision would be unneeded precision – specify Tru-Rol for the job.

Tru-Rol Bearings provide above-commercial-grade efficiency . . . at worthwhile savings in cost. Internal clearances are closely controlled. Rollers are equally spaced to eliminate out-of-balance vibration. Each roller is crowned to distribute the load evenly along the full length of the roller. Eleven types available in single and double width bearings, in stamped steel retainer, segmented retainer or full roller construction.



ELEVEN TYPES AVAILABLE

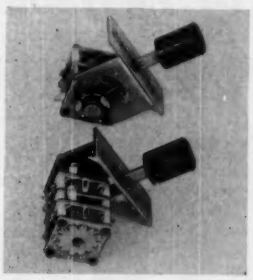


Ask your nearby Rollway Service Engineer to detail the quality you *should be getting* in your "commercial grade" bearings. Or write for the Rollway Tru-Rol catalog showing the full line, and capacity and size ranges. ROLLWAY BEARING COMPANY, INC., Syracuse, N. Y.

ROLLWAY®
BEARINGS
COMPLETE LINE OF RADIAL AND THRUST CYLINDRICAL ROLLER BEARINGS

ENGINEERING OFFICES: Syracuse • Chicago • Toronto • Cleveland • Seattle • San Francisco • Boston • Detroit • Pittsburgh • Houston • Philadelphia • Los Angeles

Circle 537 on Page 19



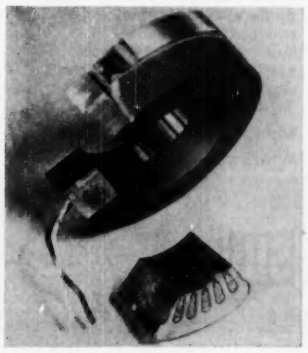
mounting, and lever operation in a compact unit suitable for low-power and electronic circuits. Assembly can be furnished with either one or two sections, giving up to 12-pole switching. Lever actuator can be arranged to be spring-returned to center from either or both of two end positions, or can be maintained in any or all of the three positions, or limited to two positions. Electrical ratings are 3 amp continuous current at 115 v ac, interrupting rating, ½ amp at 115 v ac, voltage breakdown 1000 v rms. **Electro Switch Corp.**, 167 King Ave., Weymouth 88, Mass. B

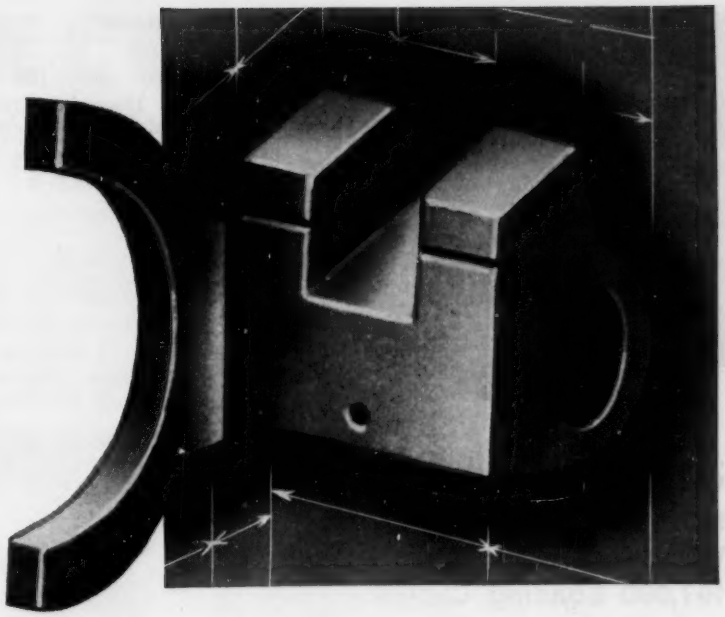
Circle 766 on Page 19

Epoxy-Casting System

is shock resistant

Hysol 6622 epoxy-casting system is designed for embedding electric motor stators and transformers, and is also suitable for casting or potting large masses where exotherms cannot be tolerated. It is excellent for potting circuits and transformers having strain-sensitive elements. Hysol 6622-105 (filled) has successfully passed requirements of MIL-T-27A. It offers excellent resistance to thermal and mechanical shock through its flexibility. Castings containing large steel inserts of various configurations have been





this new part brings outstanding cost reductions...

The photograph is of a shifter fork used in the transmission of a very popular garden tractor in volume production.

Clearly evident is the economy that can be achieved by powder metallurgy over other previously used methods. The elimination of practically all machine work effects striking cost reduction.

Made of pure powdered iron, infiltrated with copper to give added strength and ductility, this part is intended to meet the higher physical properties of wrought metals.

The user of this part naturally presented his problem to Bunting first.

For the unusual, as well as the usual, in bearings, bushings, bars and special parts of cast bronze, sintered metals, or Alcoa aluminum, see Bunting first.

BUNTING SALES ENGINEERS in the field and a fully staffed Product Engineering Department are at your command without cost or obligation for research or aiding in specification of bearings or parts made of cast bronze or sintered metals for special or unusual applications.

...ask or write for your copy of...

Bunting's "Engineering Handbook on Powder Metallurgy" and Catalog No. 58 listing 2227 sizes of completely finished cast bronze and sintered oil-filled bronze bearings available from stock.

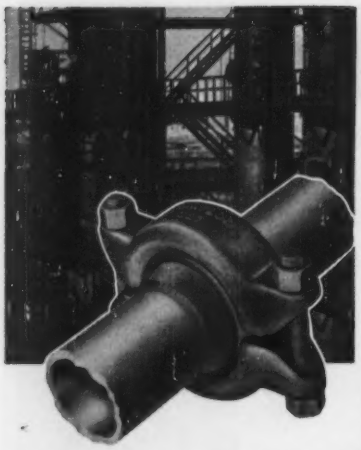
The Bunting Brass and Bronze Company
Toledo 1, Ohio EVergreen 2-3451

Bunting®

Branches in Principal Cities

BEARINGS, BUSHINGS, BARS AND SPECIAL PARTS OF CAST BRONZE OR SINTERED METALS. ALCOA® ALUMINUM BARS

Circle 538 on Page 19



GRAYLOC Connections Hold High Pressures With No Leaks During 197,000 Loading Cycles

GRAYLOC connections in use at a Texas chemical plant* were cyclically loaded with pressures from 2,500 to 9,000 psi 197,000 times without a leak. Although these connections are rated at 12,000 psi, two of them were tested at maximum static pressure to learn whether fatigue action had changed the ultimate capacity. Both held at pressures far exceeding rating and one held without leakage to 27,000 psi.

When high pressures are your problem, specify GRAYLOC connections for safety, low initial cost, low maintenance cost. Write for the whole technical GRAYLOC Test Data story today.

*Taken from a letter in our files

GRAY Tool Company

5901

P. O. BOX 2291 HOUSTON, TEXAS
REpublic 4-1641

MAIL THIS COUPON TODAY

GRAY TOOL COMPANY
P. O. Box 2291 Houston, Texas

Please send me the GRAYLOC Test Data.

Name_____

Company_____

Title_____

Address_____

City_____ State_____

Circle 539 on Page 19

cycled between −65 and +150 C without cracking. **Houghton Laboratories**, Olean, N. Y. N

Circle 767 on Page 19

Black Glass

filters out wavelengths of ultraviolet spectrum

Black opaque glass filters out virtually all wavelengths of ultraviolet, visible, and near-infrared spectrum. It is available in beads and cases

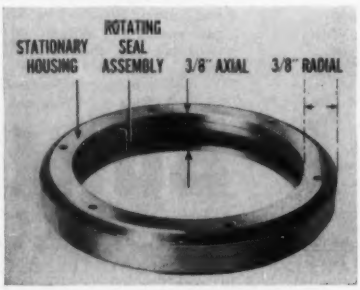
for sealing to standard 0.017-in. Dumet lead wires of silicon semiconductor devices. Glass eliminates need to paint devices, and solves problem of surface rub-off or scratching. Designated Code 9361, glass has physical properties equivalent to standard clear glass now used by diode manufacturers, and has resistivity similar to bulb glass used in standard radio tubes. Beads and cases are precision made to tight tolerances. Bead OD is 0.053 in., ±0.002 in., and ID is 0.023 in., ±0.002. Case OD is 0.095 in., ±0.002, and ID is 0.06 in., ±0.002 in. **Corning Glass Works**, Corning, N. Y. N

Circle 768 on Page 19

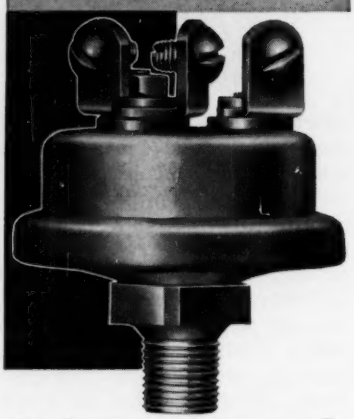
Mechanical Seal

resists pressure differentials to 30 psi

Self-contained mechanical seal suitable for temperatures to 450 F resists pressure differentials in one or



New! Hobbs dual CIRCUIT PRESSURE SWITCHES

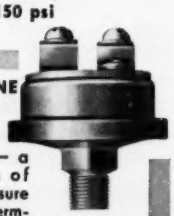


Industry-approved for a wide range of applications

Actuates two electrical circuits . . . locks out one while the other is in operation. Ideal for operating instruments, warning signals, safety devices, fuel pumps . . . in many ways for making and breaking circuits. Can be used with oil or air . . . or, with standpipe, with most liquids or gases.

Available to pound setting specification in both circuits within ranges of 3-6, 7-14 and 15-60 psi. Compact — only 1-11/16" diameter. Pressure assembled and pretested at 150 psi. Designed for use on direct current.

- Non-ferrous pressure chamber
- Phosphor-bronze diaphragm
- Alloy contacts
- Preset at the factory
- Pretested at 150 psi



A COMPLETE LINE OF PRESSURE SWITCHES

Also available — a wide selection of single circuit pressure switches. Single terminal . . . double terminal . . . normally open . . . normally closed. Pressure ranges of 3-6, 7-14 and 15-60 psi.

Distributors in Principal Cities

WRITE FOR CATALOG PS605

John W. Hobbs Corporation

Symbol of SW Excellence

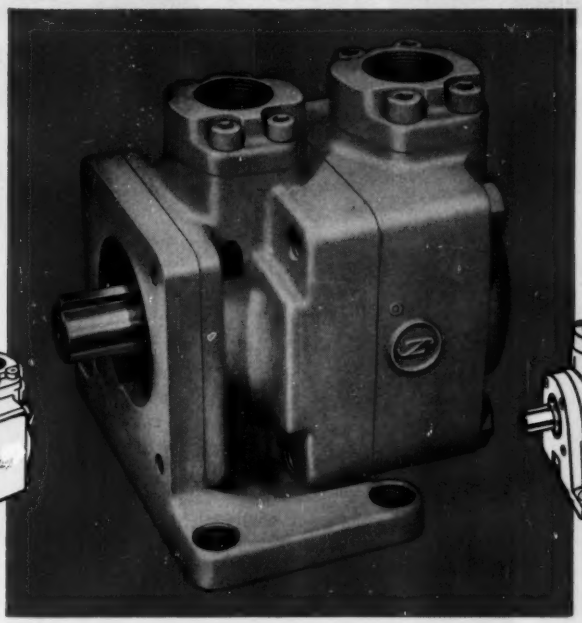
A Division of STEWART-WARNER CORPORATION

2051 YALE BLVD., SPRINGFIELD, ILLINOIS

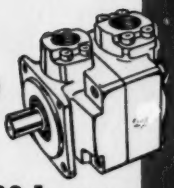
Circle 540 on Page 19

HYDRECO® Announces—

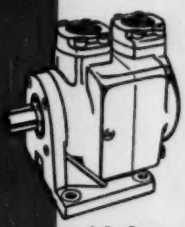
TWO NEW SERIES OF DUAL-VANE PUMPS FOR 2000 PSI CONTINUOUS OR INTERMITTENT OPERATION



PF-200



14.5 to 38.1 gpm at 1200 rpm-0 psi



PF-300

43.0 to 72.5 gpm at 1200 rpm-0 psi

CHECK THESE FEATURES

The greater efficiency and economy of 2000 psi *single stage* operation.

●

Dual-Vane construction—the proven principle of hydraulic balance—higher mechanical and volumetric efficiency.

●

Improved design of cam ring provides greatly increased cam life.

●

Two sizes give complete range of capacities from 14.5 to 72.5 gpm . . . PF-300—300 Double Pumps give capacities to 144 gpm.

●

Cartridge construction . . . Pump rotation can be changed by merely reversing cartridge.

●

Housing ports can be rotated to any position 90° to each other.

Member NFPA

NFPA NATIONAL FLUID POWER ASSOCIATION

Design engineers, seeking Vane Pumps that deliver substantial improvement in performance, longer service life and higher over-all efficiency will find much of interest in these HYDRECO Dual-Vane Pumps. Whether the application imposes the exacting performance of automated production machinery or hydraulic presses, these HYDRECO Dual-Vane Pumps possess the long-sought extras.

For continuous or intermittent 2000 psi operation, these Pumps are outstanding. Within the capacity range of 14.5 to 144 gpm obvious applications include: Injection Molding, Die Casting, Hydraulic Presses, Scrap Balers and Metal Working Machinery. There are many other areas wherein the advanced design and high performance features of HYDRECO Dual-Vane Type Pumps will excite special interest. Write for full information today.

Write **for Bulletin 10420.1 and performance data**

HYDRECO DIVISION

THE NEW YORK AIR BRAKE COMPANY

9006-12 EAST MICHIGAN • KALAMAZOO • MICH.

Please send me Bulletin 10420.1 and performance curves on Series PF-200 and PF-300 HYDRECO Dual Vane Hydraulic Pumps.

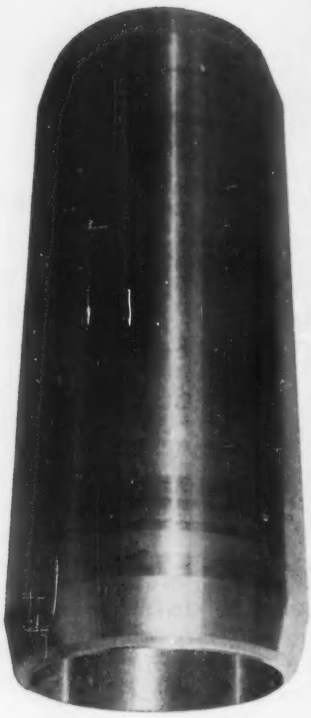
Name_____

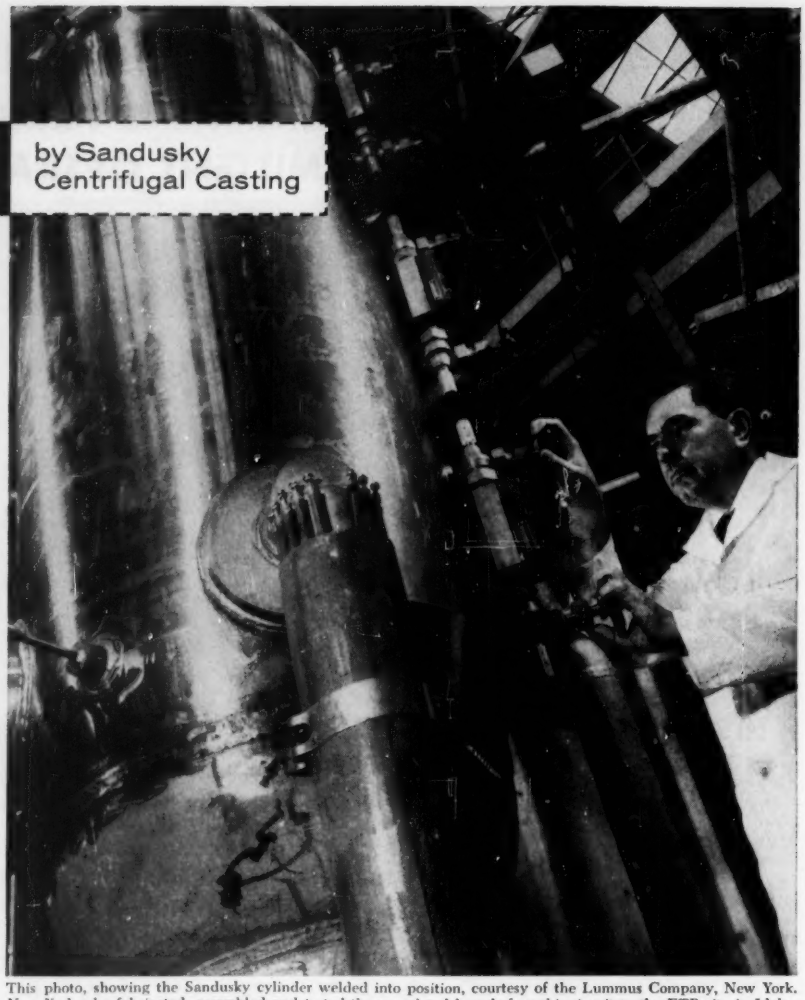
Company_____

Address_____

City_____ Zone_____ State_____

SOLVED: by Sandusky Centrifugal Casting





This photo, showing the Sandusky cylinder welded into position, courtesy of the Lummus Company, New York. New York who fabricated, assembled and tested the completed loop before shipping it to the ETR site in Idaho.

Nuclear Test Loop Uses Sandusky Centrifugal Casting as Pressurizer Cylinder

A Sandusky Centrifugal Casting is the main cylindrical component of an electrically heated pressurizer, designed by Knolls Atomic Power Laboratory to Section VIII, of the ASME Code (Unfired Pressure Vessels) for use in the new Engineering Test Reactor facilities at Idaho Falls, Idaho.

This 66¼″ long cylinder, 27″ O.D. with walls 2½″ thick, was centrifugally cast of an 18-8 stainless steel (SA-351, Grade CF-8) for the extra corrosion resistance required under nuclear loop service conditions: demineralized water at temperatures to 650°F and pressures to 2500 PSI.

O. G. Kelley Co., Boston, to whom we delivered this 2-ton, fully machined cylinder, welded on the forged heads and nozzles, radiographed the welds, and hydro tested the completed vessel to 4300 PSI.

This is another example of the adaptability of Sandusky Centrifugal Castings to applications demanding the highest order of quality. They may well offer you a practical and economical answer to your cylindrical needs, also.

We are producing cylinders and piping in diameters from 7″ to 54″—in lengths to 33 ft.—in a wide range of ferrous and non-ferrous alloys. Write for Bulletin 300, for more complete technical information on the Sandusky process and product application data.

SANDUSKY CENTRIFUGAL CASTINGS
FOUNDRY & MACHINE CO.

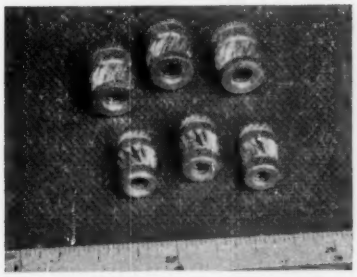
SANDUSKY, OHIO—Stainless, Carbon, Low-Alloy Steels—Full Range Copper-Base, Nickel-Base Alloys

both directions to 30 psi at shaft speeds to 15,000 sfm. Compact seal design requires only about one-fourth the axial space usually needed for seals of this type. Available for shaft sizes from ½ to 8-in. diam, seal retains water, gases, and any type of lubricant with viscosity from kerosene to heavy greases. Enclosed seal assembly revolves with shaft with two-point static shaft contact so that shaft scoring or wear is not possible. Seal is designed for press fit in housing cavity. Spring-loaded split-grip ring transfers rotation from shaft to seal assembly. Seal is available for a variety of mounting methods. **Seal Div., Universal Grinding Corp.**, 2200 Scranton Rd., Cleveland 13, Ohio. F

Circle 769 on Page 19

Screw Insert

for aluminum, brass, steel, or plastic



Torq-Loc screw insert is pressed in, yet has holding force equal to or greater than conventional inserts. No tapping operation is involved, and there are no chips to remove. Holding feature is entirely independent of screw, and screw is easily inserted or removed in conventional manner. Unit can be used in aluminum, brass, steel, or plastic. **Bergen Laboratories Inc.**, 60 Spruce St., Paterson, N. J. D

Circle 770 on Page 19

Miniature Brake

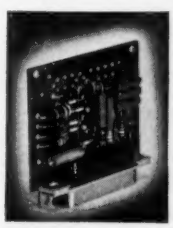
has output torque of 16 oz-in.

Miniature electromagnetic wafer brake (frame size 8) with over-all length of 0.405 in. and output torque of 16 oz-in. is suitable for use in airborne and other miniaturized control applications. Manufactured to meet or exceed applica-

A topper in any language

It's better than the best XXXP grade, it's lighter and more economical than G-10, it's Taylor XY-1 Paper-Base Epoxy Laminate

When you want extremely high reliability in printed circuits, with the additional advantages of flame retardance, chemical resistance, good solderability and high bond strength—specify Taylor XY-1 copper-clad laminate. It is self-extinguishing in 1 second, has excellent resistance to alkalis, acids and solvents, has a solder time resistance at 500°F. of 30 seconds in 1-oz. copper and 50 seconds in 2-oz., and a bond strength of 10 lb. in 1-oz. copper and 13 lb. in 2-oz. Sheets available with copper on one or both sides.



Unclad Taylor XY-1 has many advantages, too. It can be substituted for glass-base epoxy laminates to reduce cost and weight. It has excellent electrical, mechanical and machining properties. Contact us for complete technical data and expert guidance in applying this new material. TAYLOR FIBRE CO., Norristown 47, Pa.

Taylor

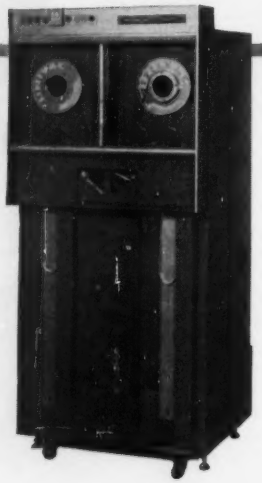
LAMINATED PLASTICS VULCANIZED FIBRE

Circle 543 on Page 19

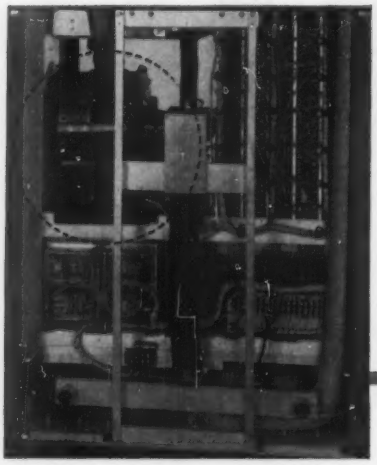
in this data processing equipment . . .

a SPENCER Vacuum Unit Solved TWO design problems!

Uniservo for Remington Rand Univac® II system.



How to maintain proper tension on the metal or plastic tape was one problem. How to cool the tubes was another.



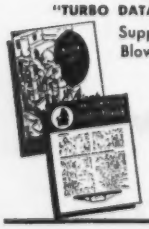
A ⅓ H.P. SPENCER vacuum unit solved *both* design problems. Intake side is utilized to keep the tape taut . . . exhaust is used to ventilate the cabinet and keep tubes cool.

Perhaps vacuum can help solve *your* design problem. Why not check with SPENCER, manufacturers of a complete line of vacuum and blower units . . . for standard or special requirements.

Two Catalogs to Aid the Designer

"132 UNUSUAL USES OF SPENCER VACUUM"
Bulletin 144 illustrates and describes how Spencer Vacuum is used in industries from A to Z.

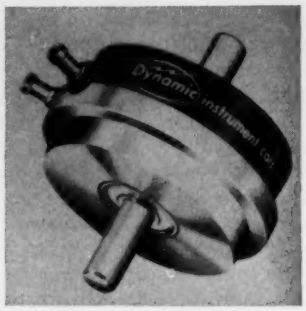
"TURBO DATA BOOK"
Supplies application data on Spencer Blowers. Request Bulletin 107-C.



STANDARD CAPACITIES
of Spencer Vacuum Producers
2 through 400 H.P.
Up to 12" Mercury Vacuum
Volumes up to 17,000 C.F.M.

The SPENCER TURBINE COMPANY
HARTFORD 6, CONNECTICUT

Circle 544 on Page 19



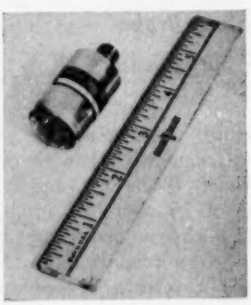
ble military specifications, brake has no slip rings, brushes, rotating coils, or other moving electrical parts. Power consumption is 2 w at 24 v dc, and operating temperature range is −55 to +125 C. Magnetic design eliminates bearing thrust load to increase life of bearings and provide extremely low drag torque. Unit weighs only 0.7 oz. **Dynamic Instrument Corp.**, 59 New York Ave., Westbury, L. I., N. Y. D

Circle 771 on Page 19

Pressure Switch

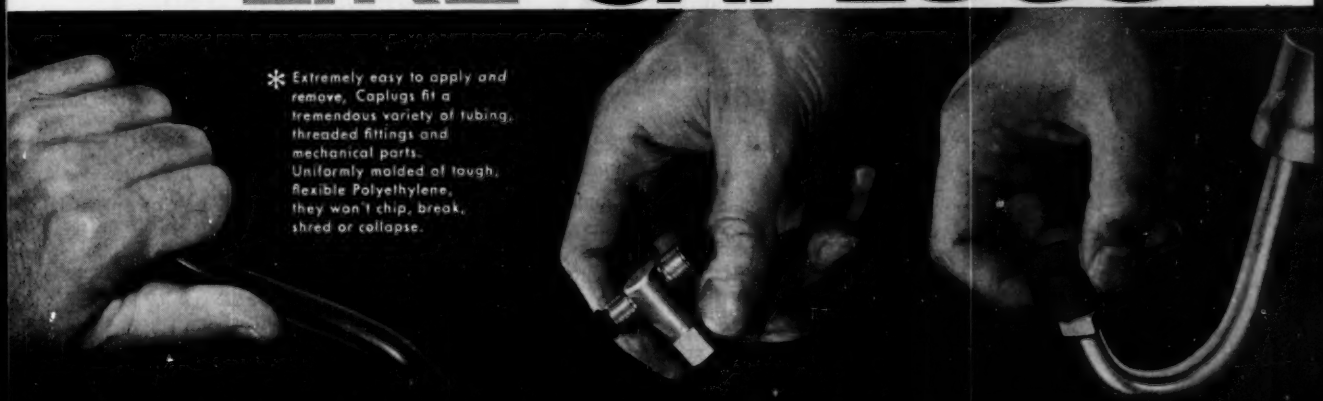
for temperatures from −85 to+400 F

Subminiature absolute air pressure switch, Model RR-58, is particularly suited to application on aircraft, missile, vibrating and moving machinery as a control or safetly device. It monitors a constant pressure over a wide temperature range and is stable under high shock and vibration. Unit is available in an actuating pressure range of 5 to 30 psia. Able to perform in a temperature range of −85 to +400 F, switch has accuracy of ±0.5 psi from −85 to +185 F and ±1.5 psi from 185 to 400 F. Weighing less than 1.8 oz and measuring 1-27/32 in. long and ⅞ in. in diam, switch meets specifications of MIL-E-5272, ±20 g shock, 75-500 cps at 10 g



with over 500 sizes in a dozen different styles now in stock

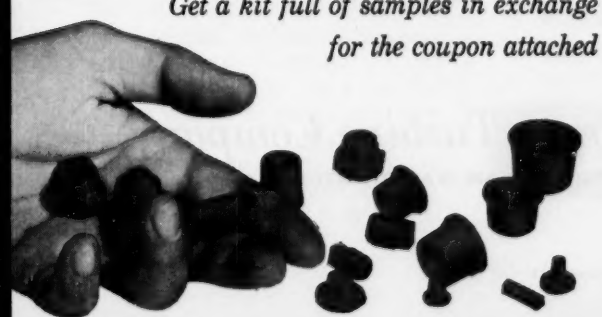
THERE'S REALLY NOTHING LIKE CAPLUGS*



* Extremely easy to apply and remove, Caplugs fit a tremendous variety of tubing, threaded fittings and mechanical parts. Uniformly molded of tough, flexible Polyethylene, they won't chip, break, shred or collapse.

to keep products safe and sound during process, storage and transit

Get a kit full of samples in exchange for the coupon attached



CAPLUGS DIVISION, PROTECTIVE CLOSURES CO., INC.
2201 Elmwood Ave., Buffalo 23, N.Y.

Mail a free assortment of Caplugs, literature and prices to us, without obligation.

Circle 545 on Page 19

NAME _____ TITLE _____

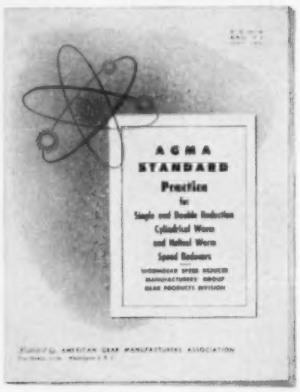
FIRM _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

DE LAVAL offers new A.G.M.A. Gear Standards Booklet for Engineers

You will not want to be without this newly published American Gear Manufacturers Association booklet. It outlines the new standards for single and double reduction cylindrical worm and helical worm speed reducers.



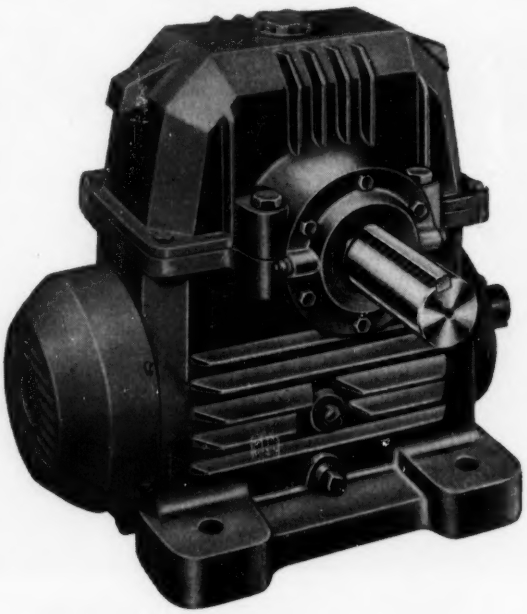
Get this new A.G.M.A. 440.03 booklet free of charge by request on your company letterhead.

This new standards booklet contains important design data including: Power rating of worm gears • Ratio correction factor (Km) • Materials factors (Ks) • Velocity factor (Kv) • Coefficient of friction (μ) • Thermal factor • Service factors • Efficiency • Overhung load capacity • Lubrication.

The materials factor (Ks) and the coefficient of friction (μ) are new, reflecting the latest advances made in worm gearing in the past few years.

We have also recently published our new Delroyd Worm Gear Sets Catalog 3800 and Delroyd Single Reduction Worm Gear Catalog 3805, which contain comprehensive information on the selection of these units.

De Laval furnishes worm gearing under the trade name DELROYD and has a complete line from $1\frac{1}{8}$" to 36" center distance, in horsepower ranges from .04 to 700 and in ratios from 5: to 4900:.



DE LAVAL *Steam Turbine Company*

858 NOTTINGHAM WAY, TRENTON 2, NEW JERSEY

DL-482

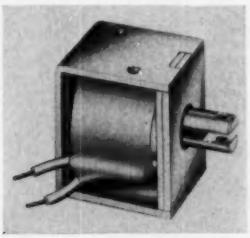
vibration. Unit employs snap-action switch with electrical connections through hermetic seals. Available as SPST or SPDT, it is rated at 28 v dc, 110 v ac, and 5 amp resistive load. Newark Controls Co., 15 Ward St., Bloomfield, N. J. D

Circle 772 on Page 19

Midget Solenoid

is available in ac or dc types

No. 28 midget solenoid has overall dimensions of 1⅛ x 1 x 1-3/16 in. and weighs approximately 3½ oz. It is available in ac or dc types, intermittent or continuous duty. Tapered plug and plunger provide



high power. Plunger strokes from 1/6 to ½ in. with lift of over 41 oz. Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill. J

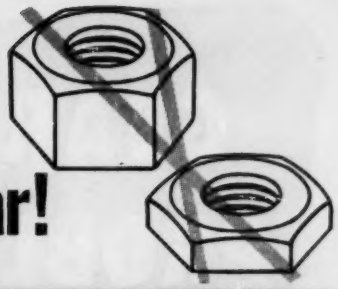
Circle 773 on Page 19

Epoxy Adhesive

is low-cost, 100 per cent-solids type

Bondmaster M685 is a 100 per cent-solids, unfilled, modified epoxy adhesive. The two-part, room-temperature-curing formulation was originally developed for bonding rigid expanded polystyrene to metal, wood, and to other rigid surfaces where operating temperatures well in excess of 120 F are encountered, or where other unusual service conditions make use of conventional solvent-dispersed, rubber-resin formulations impractical. Material also has applicability for economical metal-to-metal and metal-to-plastics general-purpose bonding where strengths of epoxy order are required, and for sandwich-panel construction. Adhesive is a free-flowing, clear, pale-amber liquid. At room temperature, bonded assembly can be handled in 6 to 8 hr and

Save 65¢ on each Fastener Dollar!



Replace expensive heavy nuts and jam nuts with low-cost, vibration-proof

PALNUT TYPE R LOCK NUTS

All PALNUT Lock Nuts provide attractive savings—but in sizes from ⅜" and up, the ratio of economy increases dramatically. On many applications, Type R PALNUT Lock Nuts can do the job better, at ⅓ the price! PALNUT spring-tempered steel lock nuts provide rugged assembly for loads in shear and moderate tensile loads, in sizes up to 2½" diameter. In addition, you get the following design and cost advantages:

- Vibration-proof assemblies without lockwashers.
- Save Space—need only 3 bolt threads, permit shorter bolts.
- Save Weight—PALNUTS weigh 65% less than plain nuts, 80% less than plain nut and lockwasher.
- Precision Made—always fit screw threads.
- Fast Assembly with hand or power tools.
- Sizes from #3-48 Machine Screw through 2½" American Standard Heavy.

Above: A 5/16"-18 PALNUT securely fastens inlet nipple in airplane brake assembly.

Right: A ¾"-20 PALNUT used on base assembly of food mixer.

Above: A 1"-14 PALNUT holds rear view mirror bracket to cowl of automobile.

Write for literature and free samples, stating type, size and application.

THE PALNUT COMPANY, 75 Glen Road, Mountainside, N. J.

In Canada: P. L. Robertson Co., Ltd., Milton, Ont.

PALNUT® LOCK NUTS FASTENERS

Quick, secure fastening at low cost

Circle 546 on Page 19

GEAR PROBLEMS?

—check with

FAIRFIELD!

GEAR PERFORMANCE to match the ever-increasing power and speed of modern machines is a Fairfield specialty. This is possible because Fairfield has long held a position of leadership in utilizing the most advanced methods, equipment, and techniques for producing better gears. By keeping apace with modern engineering trends, Fairfield renders an invaluable service to many of the nation's leading machinery builders.

If you have a gear problem, check with Fairfield. Our engineers are well-qualified to give you expert recommendations. CALL OR WRITE.

SPUR GEARS—Straight, helical, and internal. Sizes from 16 pitch, 1½" dia., to 1½ pitch, 36" dia.

HERRINGBONE—(Fellows Type). Sizes from 1½" to 15"

SPIRAL BEVEL—Sizes from 16 pitch, 1½" dia., to 1½ pitch, 28" dia.

STRAIGHT BEVEL—Sizes from 16 pitch, 1½" dia., to 1½ pitch, 28" dia.

HYPOID—Sizes from 1½" to 28" dia.

ZEROL—Sizes from 16 pitch, 1½" dia., to 1½ pitch, 21" dia.

WORMS AND WORM GEARS—Worms to 7" dia. Worm gears to 36" dia.

SPLINED SHAFTS—Lengths to 72".

DIFFERENTIALS—3,000 to 500,000 inch pounds capacity.

Note: All of the sizes above are approximate.

FAIRFIELD MANUFACTURING COMPANY, INC.

2307 S. Concord Rd. Lafayette, Indiana

TELEPHONE: 2-7353

Ask for interesting, illustrated bulletin.

Gears and Differentials Made to Order for:

TRACTORS • HEAVY DUTY TRUCKS • AGRICULTURAL MACHINERY • POWER SHOVELS AND CRANES
MINING MACHINES • ROAD GRADERS • BUSES • STREET SWEEPERS • INDUSTRIAL LIFT TRUCKS

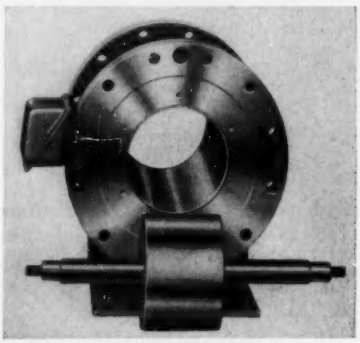
develops 85 per cent of maximum strength in 14 to 24 hr. **Rubber & Asbestos Corp.**, Dept. P, 225 Belleville Ave., Bloomfield, N. J. D

Circle 774 on Page 19

Pump Motor

handles highly corrosive or volatile liquids

Stainless-steel canned pump motor, produced in sizes from ½ to 5 hp, handles nuclear contaminated, highly corrosive, or highly volatile liquids. Dimensions follow those of NEMA specifications for next higher horsepower at same motor speed. Bearing type and material depends on temperature and chemical composition of liquid being pumped. Stainless ball bearings,



carbon block, glass, Teflon, sintered bronze, Teflon-impregnated bronze, and other materials are available for bearing use. Stainless-steel liners and covers are welded to form a perfect seal over each welded surface. End brackets are attached with O-ring seals, and stators are completely sealed. Units can be submerged. Motors are supplied separately or as a completed unit with pump attached. **Peerless Electric Div., H. K. Porter Co. Inc.**, Warren, Ohio. G

Circle 775 on Page 19

Cast-Plastic Gears

are made to tolerances as close as 0.0005 in.

Rexolite No. 1422 cast-plastic gears offer low dielectric constant and dissipation factor at microwave frequencies. They are custom-machined to tolerances as close as 0.0005 in. Prototype gears have been used successfully in airborne

Circle 547 on Page 19

Circle 548 on Page 19→

New!

Allen-Bradley Bulletin 700 Type BR Relay with Easily Convertible Contacts

Bulletin 700 Type BR relay with four poles arranged for normally open contact operation.

Changeover made in seconds!

The contacts of the new Type BR relay can be arranged for either normally open or normally closed operation—and any changeover in the field can be made in seconds. A screwdriver is all that's needed.

Sets new standards in mechanical life and contact reliability!

This all-new addition to the A-B line of Bulletin 700 control relays has been designed to keep pace with the developments and progress in modern industry. The Type BR relay particularly satisfies the requirements of modern automatic machines where the control functions must be altered frequently to meet new and changing production requirements.

Quick and easy convertibility of the Type BR contacts from normally open to normally closed contacts —or vice versa—enables "on-the-spot" changes. Such built-in contact flexibility of the Type BR relays can be used to reduce relay inventories.

Exhaustive laboratory and field tests have indicated that the new A-B Bulletin 700 Type BR relays will establish new standards for the mechanical life and contact reliability for this general class of industrial relay.

Another great convenience for the user lies in the fact that a convertible auxiliary contact can be added to either or both sides of the Type BR relay—having full switching capacity—without disturbing the wiring or removing the relay. These auxiliary poles are easily mounted from the front.

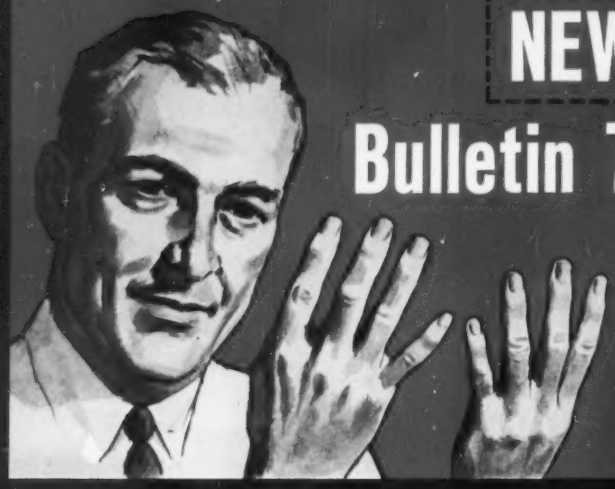
Of course, all Type BR relays have double break, silver alloy contacts that never need attention. The cast-plastic coil is impervious to the most severe atmospheric conditions.

Please write for full details on this latest addition to Allen-Bradley's line of *quality* industrial relays, today!

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis. In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY QUALITY MOTOR CONTROL

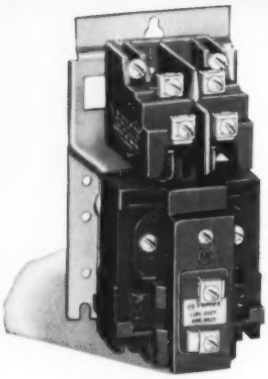
10-59-MR



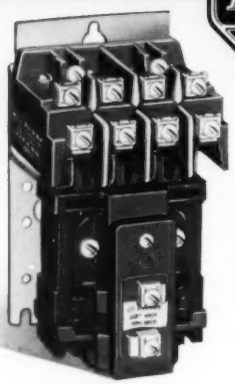
NEW Allen-Bradley Bulletin 700 Type BR RELAYS

are available with from two to eight poles— all with contacts *easily convertible* from N. O. to N. C.

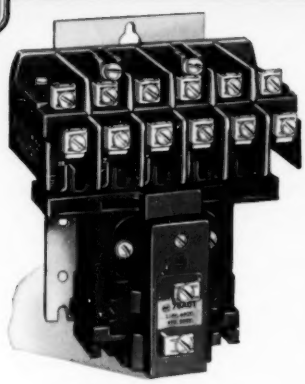
A-B QUALITY



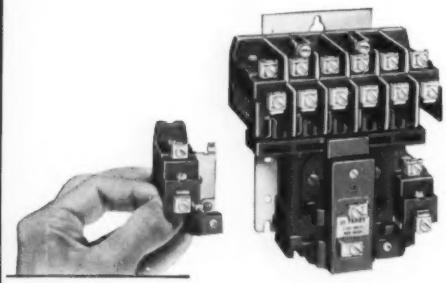
Two Pole Construction



Four Pole Construction



Six Pole Construction

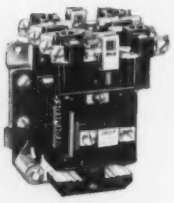


Two extra convertible poles can be easily added—in the field

An auxiliary convertible contact pole—having full switching capacity—can be easily added to the left and right sides of the Type BR relays. These auxiliary poles are front-mounted and can be added without disturbing the wiring of the relay—and without removing the relay. All relays are designed to also accept stab connectors, and—all terminals are accessible from the front.

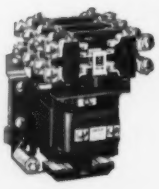
Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis. In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

Other popular Allen-Bradley industrial relays



Improved Bulletin 700 Type B
General purpose relay made with up to 8 poles.

Improved Bulletin 700 Type BX
Universal relay with both N.O. and N.C. contacts.



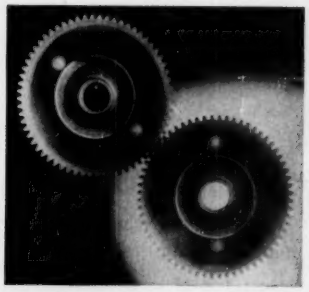
More mechanical life—greater contact reliability

10-59-MR

ALLEN-BRADLEY

Member of NEMA

Quality Motor Control



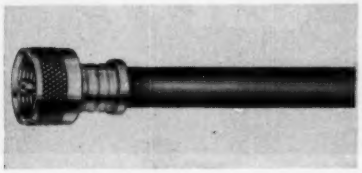
instrumentation, and have been suggested for use as components in microwave metering devices. **Rex Corp.**, West Acton, Mass. B

Circle 776 on Page 19

Coaxial Plugs

use simplified crimping method of assembly

Crimpee solderless RF coaxial plugs can be used in mobile communications equipment, ham radio sets, television master antenna sets, and in other equipment. They are readily interchangeable with military PL-259 plugs and mate with SO-239. Using a simplified crimping method for high-speed assembly, plugs are available for cable sizes RG-8/U, 9/U, 11/U, 58/U, and 59/U. They can be assembled quickly by crimping cable braid between two concentric ferrules, which are placed over cable jacket. Operation can be performed with a crimping tool.



Once crimped into place, connection will not come loose or pull apart. **Cannon Electric Co.**, P. O. Box 3765, Terminal Annex, Los Angeles 54, Calif. L

Circle 777 on Page 19

Quick-Disconnect Terminals

provide connections with special locking action

Designed for automotive, appliance, and many switch and control applications, terminals give push-on, high-pressure, spring-loaded connections that incorporate special locking action. Series includes in-

How to LOCK-UNLOCK-RELOCK the same screw in Steel without Lock Wiring or Lock Nuts

The ***Heli-Coil***® Screw-Lock Insert* is the only insert made of wire which has an exclusive resilient internal locking feature that permits repeated assembly and disassembly of the same screw This patented insert insures minimum screw wear and maximum locking torque value – it meets military specs for locking torque and vibration through 550° F.

Made of stainless steel wire, the Screw-Lock Insert protects tapped threads permanently and is not affected by acids, solvents or high temperatures You can eliminate lock nuts, lock wiring and other clumsy external locking devices The locking coil will never relax its grip even in tough metals such as meehanite, stellite, titanium, etc. The insert can be used in blind or through-holes and its frictionless stainless steel finish will not gall or seize – even under the most adverse conditions Find out about ***Heli-Coil*** Screw-Lock Inserts and get your free copy of the new data guide to drilling and tapping in *steel* Mail the coupon today.

*Patented

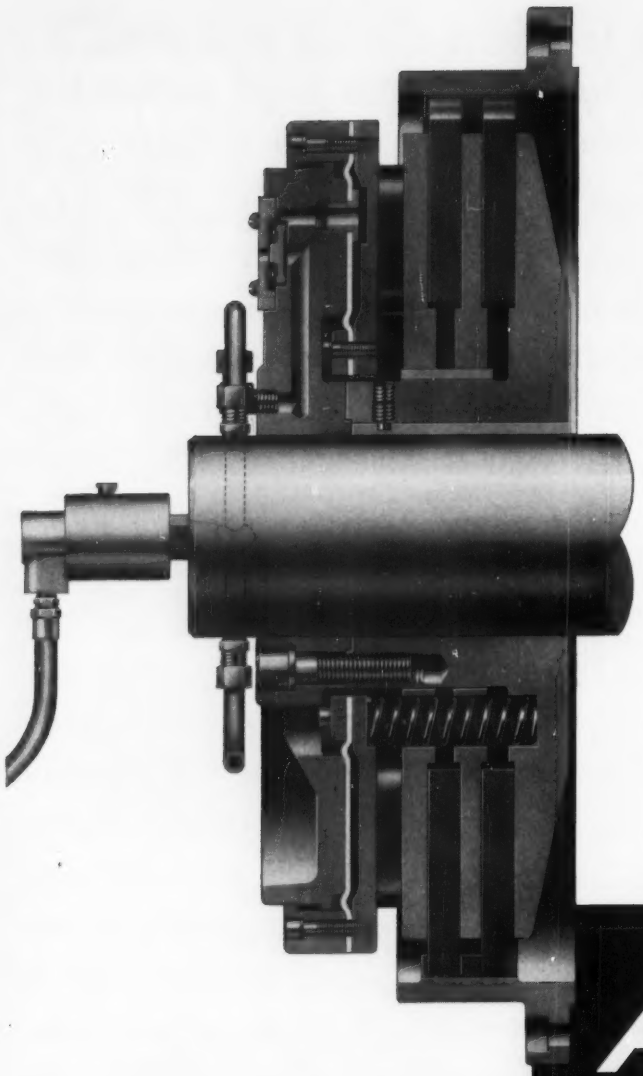
HELI-COIL CORPORATION
DANBURY, CONNECTICUT

HELI-COIL CORPORATION, 512 Shelter Rock Lane, Danbury, Connecticut
Please send my free copy of the new *Heli-Coil* DATA GUIDE TO DRILLING AND TAPPING IN STEEL, and information on *Heli-Coil* Screw-Lock Inserts.

NAME_____ TITLE_____
FIRM_____
ADDRESS_____
CITY_____ ZONE____ STATE_____ 1810

. . . or call Mr. J. L. Sutton, Customer Service Manager, PIoneer 3-7651, Danbury, Conn.

Circle 549 on Page 19



1. Quickest acting, most responsive air clutch available!
2. Finger tip control!
3. Built-in quick release valves! (Optional)
4. Requires minimum volume of air!
5. No adjustment necessary!
6. Internally ventilated—cooler operation!
7. Operates at air pressures up to 140 psi!
8. Most compact!
9. Interchanges with and can be used to replace Dodge or other mechanical clutches in existing installations.
10. Available from stock in single and double plate types. Capacities from 8.5 to 460 hp at 100 rpm at 80 psi.

AIR-GRIP

NEWER! BETTER!

DODGE

of Mishawaka, Ind.

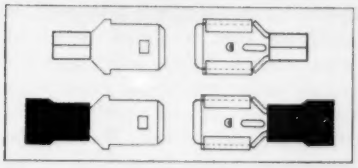
CALL THE TRANSMISSIONEER
—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone book for "Dodge Transmissioneer."

This air clutch, engineered to modern needs, provides maximum torque capacity in minimum space. Its operation requires less air, resulting in amazing sensitivity. It gives the operator split-second control—from "inching" to full engagement. Quick-release valves are built into the clutch itself, as optional equipment, for instant disengagement where such service is required.

The unique design of Air-Grip places the air seal disc at the end *farthest* from the pressure plates, which generate the heat inherent in clutch action. This combined with automatic internal ventilation, insures cooler operation and longer life under severest service. Call your local Dodge Distributor, or write for Bulletin.

DODGE MANUFACTURING CORPORATION, 3300 Union Street, Mishawaka, Indiana

Circle 550 on Page 19



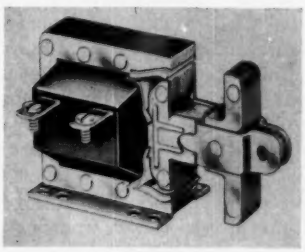
sulated and noninsulated models, straight and flag types. Wire range is 18-14 AWG. All feature closed-barrel construction for quick, easy crimping on wire and for rugged, positive connection. **ETC Inc.**, 990 E. 67th St., Cleveland 3, Ohio. F

Circle 778 on Page 19

Plastic-Protected Solenoids

have double-T plunger construction

Heavy, shock-resistant layer of epoxy resin completely protects coil windings and terminals of Series 801 double-T solenoids. Encapsulated coils offer high resistance to moisture, water, machine oils, diluted acids, and harmful alkalies. Double-T plunger construction permits use of a large air gap between plunger stem and extremities of frame legs, resulting in virtually level pull characteristics throughout useful plunger stroke. Four sizes



are available, offering 12 sets of electrical characteristics to meet requirements of almost every application. **Industrial & Commercial Controls Div., Controls Co. of America**, 9555 Soreng Ave., Schiller Park, Ill. K

Circle 779 on Page 19

Shaped Tubing

of carbon, low alloy, and stainless steel

Square, rectangular, and special-shaped carbon, low-alloy high-strength, and stainless-steel tubing is available for pressure, mechanical, heat-resisting, ornamental, and atomic applications. Variety of

How $31,000 was saved by redesigning complex assembly into single iron casting

Integral gray iron castings are a logical consideration for complex parts. An outstanding example of the savings that result when the cast iron process is used to place metal exactly where needed is this camshaft for a Teletype Printer. Formerly constructed of 31 parts laboriously machined and screwed together, an informed gray iron foundryman helped design engineers convert the assembly into a single high strength iron casting. An estimated $18,000 per year was saved in parts cost alone. Consider the gray iron process *first* in the design of complex parts. You, too, will achieve important material, weight, machining and assembly savings!

FREE DIRECTORY OF PROGRESSIVE FOUNDRYMEN

Lists modern facilities, techniques and types of iron produced by leading gray iron foundries in your area. For a copy write: Dept. G, Gray Iron Founders' Society, Inc., National City-East Sixth Building, Cleveland 14, Ohio.

Specify Modern

GRAY IRON CASTINGS

Made by Informed Foundrymen!

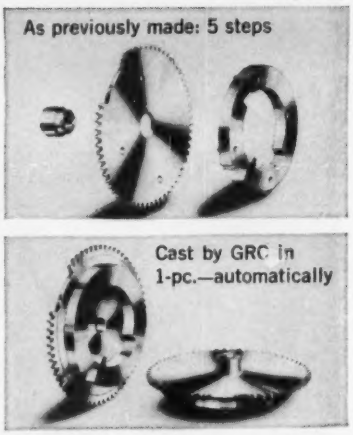
Circle 551 on Page 19

APPLIANCE TIMER GEAR MADE IN ONE STEP INSTEAD OF 5

Shown actual size

with tiny GRC zinc die casting

This mutilated gear, cam and bushing combination for an electrical appliance timer formerly required two stampings, a screw machined part and two assemblies. Die cast by GRC in one automatic operation **reduced** costs 66%, and made a **superior** product. Closer tolerances and greater uniformity were achieved by casting in one piece. Units were ready to use as cast, with no secondary operations, no scrap loss. Another demonstration of the production economies and wide design latitude Gries' exclusive methods make possible. Only the GRC Method gives such complete design freedom for small precision parts.



No Minimum Size!
Maximum Sizes: 1¾" long, ½ oz.

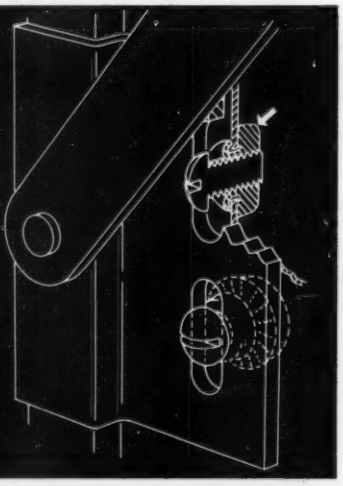
Write today for fact-filled bulletin.
Send prints for quotation.

GRIES REPRODUCER CORP.
World's Foremost Producer of Small Die Castings
32 Second St., New Rochelle, N.Y. • NEw Rochelle 3-8600

GRIES GRC

Circle 552 on Page 19

MACHINE-SET FASTENER DOUBLES AS NUT PLATE AND ADJUSTMENT SPACER

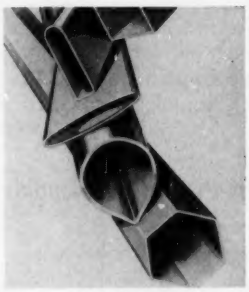


The new TRS Perma-Nut® solved a tough production problem for a large manufacturer of jalousie-type aluminum windows. It's an internally-threaded tubular rivet, fed and set by standard automatic riveters. Two Perma-Nuts in each actuating-lever pivot bracket . . . a total of 8 for a standard two-light jalousie . . . provide permanent threaded fittings for the bracket tightening screws, which pass through slotted openings for bracket position adjustment. Strong threads in the Perma-Nut head hold the screw tight, and sharp serrations under the head provide a built-in lockwasher. Perma-Nuts are available in 9 thread sizes from #3-48 to ¼-28, in steel, brass or aluminum. WRITE FOR FREE FACT-FILLED PERMA-NUT BULLETIN.

TRS TUBULAR RIVET & STUD COMPANY
Quincy 70, Massachusetts

Circle 553 on Page 19

special cross-sectional shapes is available over a broad range of sizes. Final shapes have approximately same peripheral dimensions as original round tubing from which they are formed. Round tube dimensions range from ⅝ to 6 in. OD with wall thickness from 0.028 to 0.25 in. for carbon and low-alloy



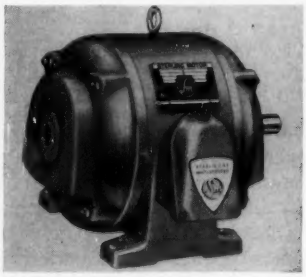
steel, and from ⅝ to 4¾ in. OD with wall thickness from 0.028 to 0.165 in. for stainless steel. **Standard Tube Co.**, 24400 Plymouth Rd., Detroit 39, Mich. T

Circle 780 on Page 19

Dripproof Motors

operate under adverse conditions

Sterlicone multishielded motors with full overload characteristics operate under adverse conditions of continuous and excessive moisture, high humidity and temperature, salt spray, dust, oil, and chemically contaminated atmospheres that previously required totally enclosed, fan-cooled protection. Flexible insulation is achieved by multiple application and controlled processing of special silicone sealing compound. Insulation is thin, nonporous, permanently resilient, and flexible. It will not chip, crack, peel, or separate under extreme temperature. Superior heat dissipation allows smaller ratings to be used. It is not subject to stress concentration



Developing a motor-driven product?

Here's a Way to Make Sure You Get the Right Motor

When you reach the point in the development of a new product where you are ready to discuss the motor, we shall welcome an opportunity to carefully study your motor problem and try to find an existing motor design that will do the job.

If the *right* motor is readily and economically available, we shall tell you. Our interest is in devoting engineering man-hours to the solution of design problems—not in duplicating development work which already has been done.

Because of this approach and because of our motor design and development experience—44 years in the small motor field—we can help your company obtain the *right* motor . . . at the most favorable cost.

THE LAMB ELECTRIC COMPANY • KENT, OHIO

A Division of American Machine and Metals, Inc.

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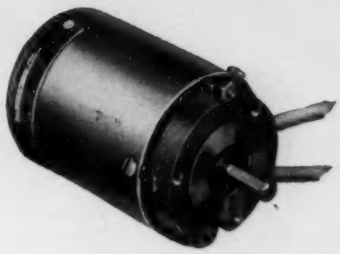
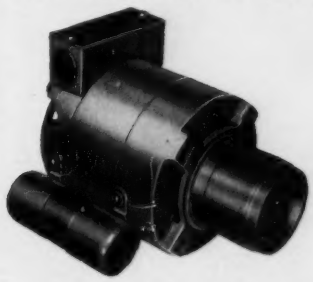
Lamb Electric

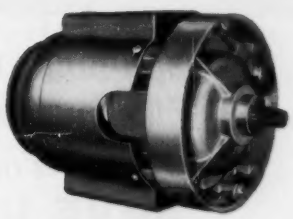
SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**



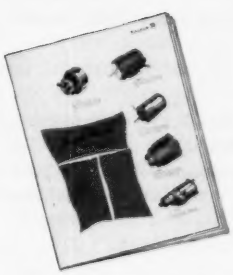
Lamb® six-pole 400 cycle AC motor for electronic cooling in missile control equipment. Frame 1 11/16 x 1¼.



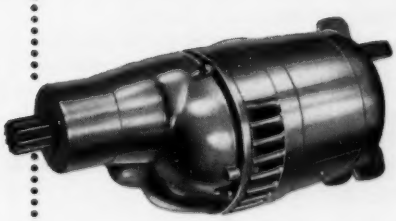
Lamb® four-pole capacitor start induction run motor with special bracket for telephone toll ticket process machine. Frame 4½ x 2¼.



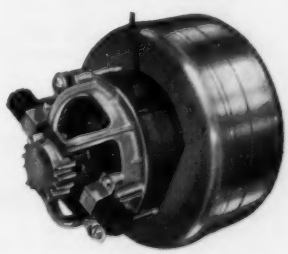
Lamb® totally enclosed fan-cooled explosion-proof motor for high pressure grease gun. Frame 3 11/16 x 2¼.



Write for your copy... 8-page folder describes these and other Lamb Electric motors.



Lamb® heavy duty three-stage gearmotor for pipe threaders. Frame 4⅜ x 2¼.



Lamb® series motor with two-stage fan—the standard for high performance domestic canister-type cleaners.

Now with General Plate Electrical Contact Tape...
You Can
SAVE UP TO 40%
On Contact Cost

In addition . . .
Contact Tape permits:

- **Broader latitude in contact assembly design**
- **Smaller contacts for same electrical loads**
- **Weight-saving**
- **Simpler material handling**

General Plate Electrical Contact Tape can be applied to any large-volume contact design, permitting the automatic assembly of two or more parts in a single operation.

Tape contacts are easily attached by spot welding methods. They are self-aligning . . . allow broader assembly tolerances. Because of this, tape contacts reduce assembly costs and eliminate or reduce adjustment time.

Tape contact material is supplied in long continuous lengths which simplify material handling.

In addition to supplying clad electrical contact tape material, General Plate is equipped to weld contact tape sub-assemblies for you.

Design engineers are invited to make use of General Plate contact engineering services . . . for material selection . . . parts design . . . samples.

Let us make an electrical contact cost analysis on products you want to automate. Find out how General Plate electrical contact tapes, as well as other clad contacts, can be put to work for you.

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GENERAL PLATE PRODUCTS: Clad Metals • Electrical Contacts • Truflex® Thermostat Metal • Platinum Metals • Reactor Metals • Radio Tube & Transistor Metals

or to production of hot spots. Motors are available in all ratings from ½ to 50 hp, any phase, frequency or voltage, torque or slip characteristics, and with multispeed winding. **Sterling Electric Motors**, 5401 Telegraph Rd., Los Angeles 22, Calif. L

Circle 781 on Page 19

Stainless-Steel Strainer

for high-pressure lines to 4000 psi

Stainless-steel strainer has screen assembly which provides a large area for dependable fluid flow and minimum maintenance at pressures

to 4000 psi. Strainer inlet and outlet are at top so that strainer can be cleaned when necessary without removal from line. Strainer is supplied for ¼, ⅜, and ½-in. high-pressure pipe lines, in choice of four mesh sizes. **Spraying Systems Co.**, 3274 Randolph St., Bellwood, Ill. I

Circle 782 on Page 19

Silicon Power Rectifier

operates at high ambient temperatures

Silicon power rectifier, Type 439, is for high-current, high-voltage applications. It provides up to 240 amp of forward current per cell, with maximum peak inverse voltage ratings to 600 v. Maximum reverse leakage current is 50 ma at rated peak inverse voltage. Features include: Operation at ambient temperatures to 190 C at junction; solid copper base; small size, with maximum cell length of 3 in. and overall weight of 8 oz. Hermetically sealed cell is nickel plated to maintain low contact resistance and to

Townsend Lockbolts now available in Stainless Steel for greater strength ...corrosion resistance

If you need extra strength in fastening your assembly—plus corrosion resistance—you can get both now with Townsend 18-8 stainless steel lockbolts.

The use of Townsend stainless lockbolts gives you greater flexibility of design and the values are highly uniform. There is no chance for human error in setting lockbolts. Men with no special training get strong, vibration-proof joints every time.

Townsend stainless lockbolts are vastly easier to install—for example, they eliminate the back breaking work of bucking stainless rivets which work-harden rapidly.

Townsend lockbolts are also available in carbon steel and aluminum alloy in a wide range of diameters and grip lengths in brazier, button and 90° countersunk head styles. Write today for information to Engineered Fasteners Division, P.O. Box 71-E, Ellwood City, Pennsylvania.

Licensed under Huck patents RE 22,792; 2,114,493; 2,527,307; 2,531,048; 2,531,049 and 2,754,703

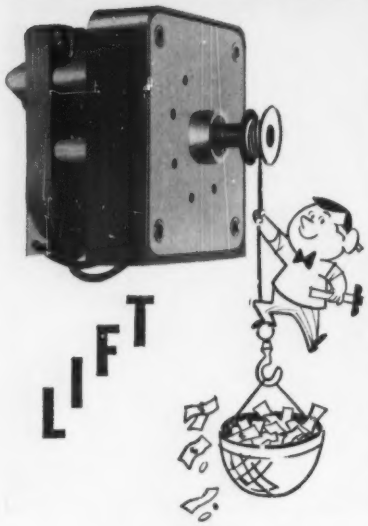
Townsend Company

Engineered Fasteners Division

ELLWOOD CITY · PENNSYLVANIA

Circle 556 on Page 19

put HEINZE in your designs



your PROFITS with HEINZE GEARMOTORS

Give your profits a real lift with low-cost, high-quality Heinze Gearmotors — for vending machines, business machines, appliances and similar applications. You have a choice of four sub-fractional horsepower driving motors — 2 pole induction, 4 pole induction, universal or reversing. Horsepower ratings are from 1/15 to 1/500. Speeds range from 700 rpm down to 1 revolution in 8 minutes. Gears withstand up to 50 in. pounds. Geartrains are enclosed or open, base or panel mounted. Gears, pinions and shafts are made from finely tempered and hardened steel. Felt oil reservoir guards against oil leakage. Oil-impregnated bronze bearings insure long, trouble-free operation.

SEND COUPON FOR NEW CATALOG

HEINZE ELECTRIC COMPANY
685 Lawrence St., Lowell, Mass.
Sub-Fractional Horsepower Motors and Blowers

HEINZE ELECTRIC COMPANY, DEP'T D
685 Lawrence St., Lowell, Mass.

Please send catalog on Heinze Sub-Fractional Horsepower Motors.

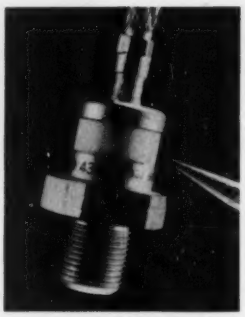
Name & Title.....

Company.....

Street & No.....

City & State.....

Circle 557 on Page 19



prevent corrosion. Rectifier case is cathode terminal. Ceramic insulation between anode and cathode provides greater creepage distance than previously available on high-voltage, high-current units. A ¾-in. stud on case permits mounting cell in any position. **Westinghouse Electric Corp.**, P. O. Box 2088, Pittsburgh 30, Pa. F

Circle 783 on Page 19

Extruded Nylon Film

is grease, abrasion, and vapor-resistant

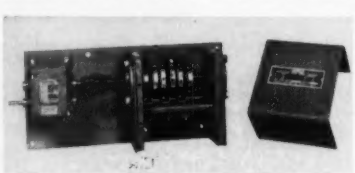
Extruded nylon film and sheet is available in thicknesses from 0.002 to 0.06 in. and in widths to 18 in. Possessing all chemical, physical, and mechanical properties of nylon, film is useful to a wide variety of industries. It is grease, abrasion, and vapor-resistant, has low coefficient of friction, low permeability factor, and can be steam sterilized. It is suitable for mass production stamping of thrust bearings, electric insulators, oil bearing items, and backup rings. **United States Gasket Co., Div., Garlock Packing Co.**, 602 N. 10th St., Camden 1, N. J. E

Circle 784 on Page 19

Limit Switch

has speed reducer with ten gear ratios

General-purpose, heavy-duty, rotating-cam limit switch incorporates a speed reducer with ten gear ratios from 25:1 to 900:1. Gear reducer



No. 8 of a series

Eastman 910 Adhesive solves another design bottleneck

Directly measuring dimensional changes in structural members under stress, strain gages provide aircraft designers with performance data at almost any point in the airframe during flight testing. As many as 8,000 gages have been used during the flight testing program of a single aircraft.

Because of its rapid setting characteristics and its ability to adhere to virtually any material, Eastman 910 Adhesive has become the preferred adhesive for attaching strain gages.

Conventional adhesives require up to 24 hours curing time before reliable readings can be taken. *Use of Eastman 910 Adhesive can reduce this waiting period to less than 5 minutes.*

Eastman 910 Adhesive is making possible faster, more economical assembly-line operations and new design approaches for many products. It is ideal where extreme speed of setting is important, or where design requirements involve joining small surfaces, complex mechanical fasteners or heat-sensitive elements.

Eastman 910 Adhesive is simple to use. No mixing, heat or pressure is required. Upon spreading into a thin film between two surfaces, setting begins immediately. With most materials, strong bonds are made in minutes.

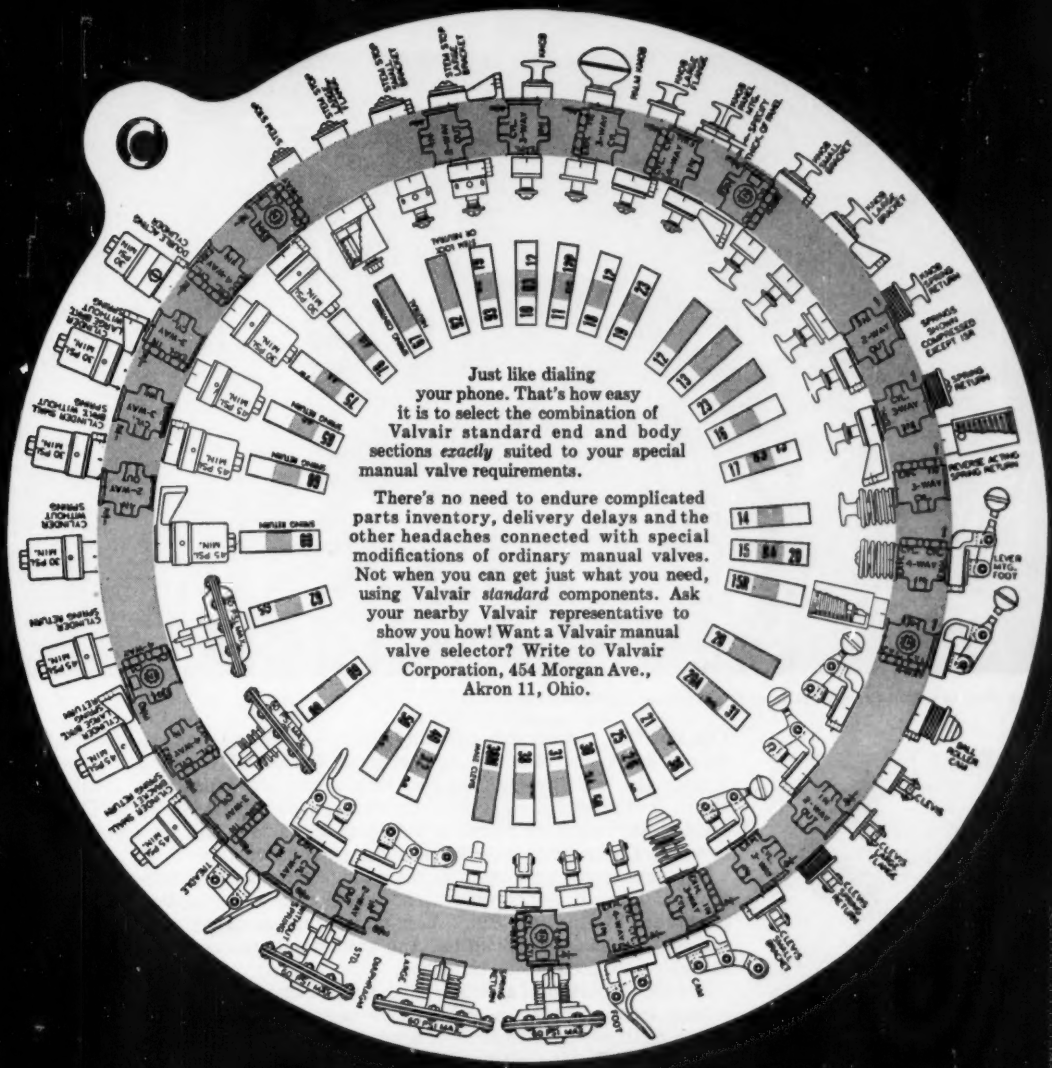
What production or design problem can this unique adhesive solve for you?

For a trial quantity (⅓-oz.) send five dollars to Armstrong Cork Co., Industrial Adhesives Div., 9112 Dean Street, Lancaster, Pa., or to Eastman Chemical Products, Inc., Chemicals Div., Dept. M-12, Kingsport, Tenn. (Not for drug use)

Circle 558 on Page 19

VALVAIR® air control valves

. . . unlimited combinations using standard components!



Just like dialing your phone. That's how easy it is to select the combination of Valvair standard end and body sections *exactly* suited to your special manual valve requirements.

There's no need to endure complicated parts inventory, delivery delays and the other headaches connected with special modifications of ordinary manual valves. Not when you can get just what you need, using Valvair *standard* components. Ask your nearby Valvair representative to show you how! Want a Valvair manual valve selector? Write to Valvair Corporation, 454 Morgan Ave., Akron 11, Ohio.

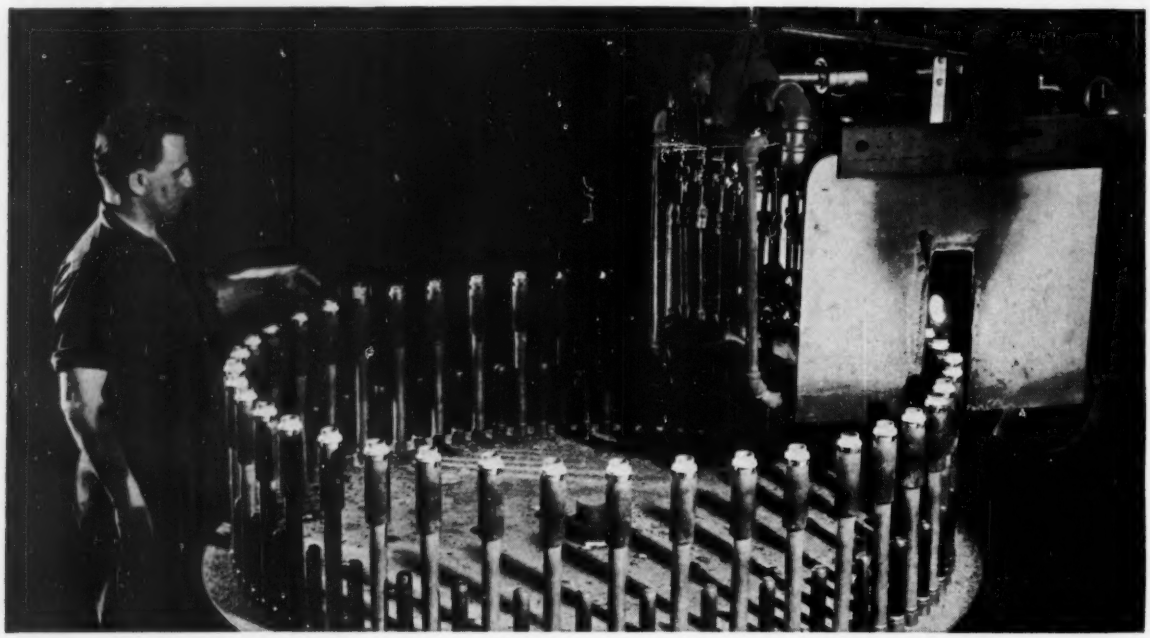
Representatives in principal cities.

Valvair AKRON 11, OHIO

DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

Other INDUSTRIAL DIVISIONS of IBEC: The Sinclair-Collins Valve Co. The Bellows Co., Akron, Ohio • V. D. Anderson Co., Cleveland, Ohio.

Every Hour M. S. Little Brass Goods Company Makes 650 Appliance Fittings Better With HANDY & HARMAN SILVER BRAZING



Rotating jig showing mounted assemblies entering and leaving gas-air furnace.

Left– brazed assembly. Right– components with preform ring of EASY-FLO *45.*

This Hartford, Connecticut, company makes—in volume—an assembly that goes into the overflow system of household appliances. The assembly consists of brass tubing and a machined brass casting. The two components are joined by a preplaced ring of Handy & Harman EASY-FLO 45 silver brazing alloy and HANDY FLUX. Heating is automatic gas-air; parts are placed on a rotating turntable to pass through the gas furnace. Every 60 working minutes, 650 assemblies are completed.

The advantages here are that the manufacturer can use thin-walled tubing with heavier, threaded components at no sacrifice in strength. Because of EASY-FLO's penetrating qualities, the entire shear area is fully as strong as the solid parts of the assembly, yet considerably lighter. And, casting and machining the components for this assembly have been greatly simplified.

Are you in pursuit of a metal-joining method which offers—among other advantages—high, uninterrupted production at low capital investment? You may easily find the answer in Handy & Harman silver brazing. Hundreds of manufacturers and fabricators of as many different products, parts and components are right now enjoying the speed, economy, strength and *flawlessness* of brazing. You can too. Just ask Handy & Harman, 82 Fulton Street, New York 38, N. Y.

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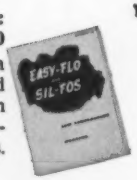
New Handy & Harman Brazing Correspondence Course. Simple self-study data on all phases of brazing. Send for details to Dept. BC.

FOR A GOOD START: BULLETIN 20

This informative booklet gives a good picture of silver brazing and its benefits... includes details on alloys, heating methods, joint design and production techniques. Write for your copy.



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Toronto, Canada

Circle 560 on Page 19

is mounted on a durable steel bed plate connected to shaft by a flexible coupling. It can be removed and replaced quickly as one complete unit. Compact in design, switch is available in standard NEMA types 1, 4, 5, 7, 9, and 12 enclosures with from 2 to 12 circuits, employing one type cam for all settings. No special cam lobes are required. Snap-action switch has one normally open and one normally closed contact which are electrically separated. **Gemco Electric Co.**, 25685 W. Eight Mile Rd., Detroit 40, Mich. T

Circle 785 on Page 19

Servo Motor-Brake

is 1.85 in. long

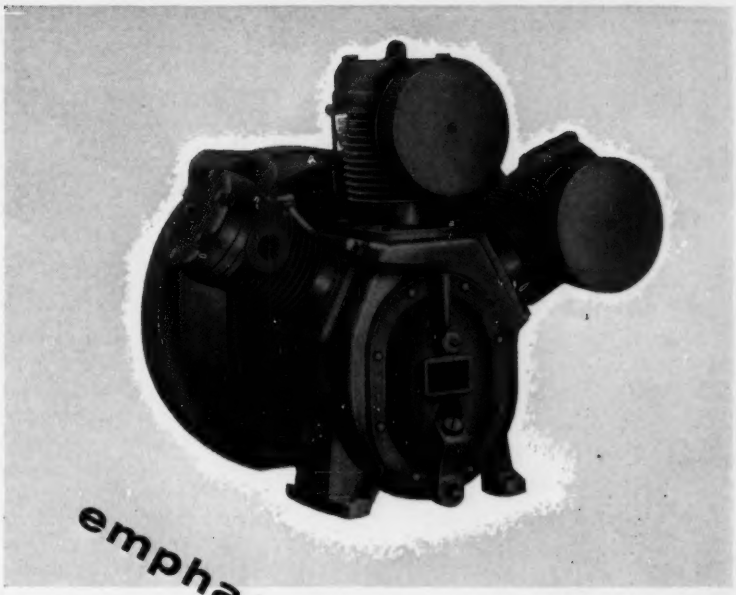
Servo motor-brake combination is designed to meet MIL-E-5272. Stall torque of motor alone is 0.48 oz-in., and brake range available is 0.03 to 0.1 oz-in., ±0.01. Size of unit is 1 in. diam and 1.85 in. long. Brake does not change linearity of speed torque characteristic. Unit has stainless housing, end bells, and shaft, and can be produced with size 10, size 11, or 1-in. mounting. Design including an integrally mounted gear box with ratios to 8000:1 is also available. **Electro Products Div., Western Gear Corp.**, 132 W. Colorado Blvd., Pasadena, Calif. L

Circle 786 on Page 19

Small Vacuum Blowers

for capacities from 30 to 1000 cfm

Ten sizes of small-volume vacuum blowers are designed for capacities from 30 to 1000 cfm and vacuum to 20 in. Hg in single-stage application. They can be compounded also for vacuum service over 20 in. Hg. Major features of design include: Elimination of internal valves, ab-



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with IR air compressors*

Ingersoll-Rand Compressors bring new efficiency to air-operated equipment through modern design and exclusive features. Engineered for trouble-free service and maximum performance, Ingersoll-Rand Air Compressors can be supplied bare, base-plate mounted or receiver mounted.

To assure dependable performance in the equipment you manufacture you'll want to specify an air compressor that's known and recognized as the best. The people you're going to sell *know* that Ingersoll-Rand Air Compressors set the standard for dependable, low-cost operation.

Ingersoll-Rand
11 Broadway, New York 4, N.Y.

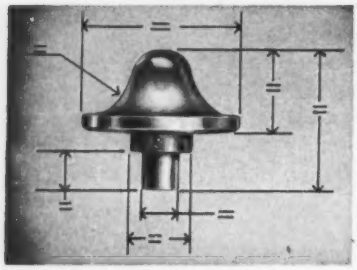
* air-cooled compressors ½ through 20 horsepower
Other compressors to 6000 horsepower

3-676

Circle 561 on Page 19

Manufacturers of Cold Headed Fasteners Since 1888

OVER 10 TIMES THE RATE AT 50% SAVING IN RAW MATERIAL



Another example of how Hubbell Cold Heading produces Better Parts at Faster Speeds, at Lower Cost

THE PART:
Click Button

THE MATERIAL:
Brass

THE METHOD:
Hubbell cold heading in place of screw machining.

THE RESULT:
This brass click button was machined previously from bar stock, involving several different operations that removed nearly 50% of the total weight of the original stock . . . a wasteful, time-consuming, costly process.

Hubbell now produces essentially the same part at tremendous savings in time and material cost.

a. Production is increased from the original rate of 5.5 pcs. p.m. to cold heading rate of 60 pcs. p.m.

b. Labor, overhead and material cost has been reduced 36%.

c. The finished part is stronger, more accurate, with greater uniformity.

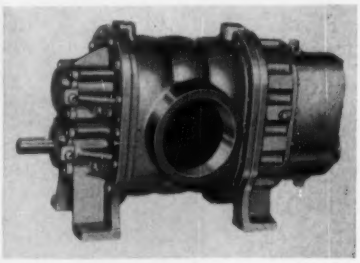
Hubbell Cold Heading may provide equally dramatic results for you. Whether it is presently cold headed or not, send blueprint of part or sample for analysis and estimate.

HARVEY HUBBELL, Inc. *Machine Screw Dept.*
Bridgeport 2, Connecticut

Kindly estimate on the enclosed sample (blueprint) Quantity _____

Name _____
Title _____
Company _____
Address _____

Circle 562 on Page 19



sence of contact between moving parts, maximum efficiency of rotor design and operating speeds, and minimum sealing-water requirements. At reduced vacuums, units can be operated without sealing water, depending upon specific application. **Roots-Connersville Blower Div., Dresser Industries Inc.,** 900 W. Mount St., Connersville, Ind. J

Circle 787 on Page 19

Polyester Material

withstands 300-hr dust-fog tracking tests

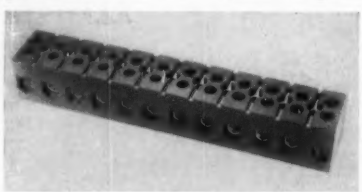
AT-136 glass-fiber polyester material is available for molding as components on electrical circuit breakers and a variety of other switchgear equipment. It has withstood 300-hr dust-fog tracking tests under proposed ASTM specification. **Reinforced Plastics Div., Hays Mfg. Co.,** 803 W. 12th St., Erie, Pa. F

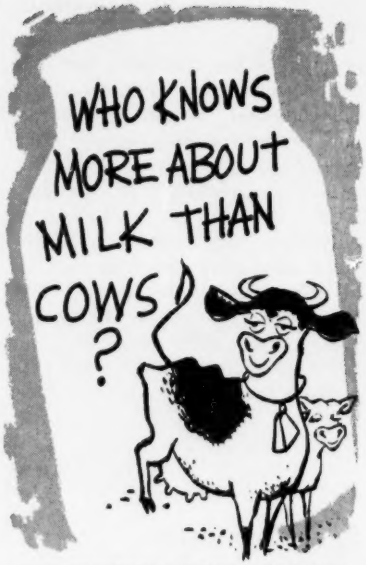
Circle 788 on Page 19

Terminal Blocks

for heavy-duty uses

Type 9-85 pressure-contact terminal blocks provide a viselike grip on each wire of through-connected pairs, eliminating soldering and providing extra safety against accidental shocks. Blocks are suitable for control cabinets, industrial air conditioners, furnace controls, electronic power equipment, and other applications where cables handling heavy amperage and high voltage are to be joined together. Blocks are of one-piece construction, molded of gen-





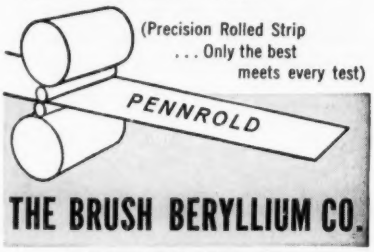
From raw material to finished product, she's the boss at every stage of production.

For the same reasons, only the company who controls metallurgical quality of beryllium copper from raw ore to finished strip can furnish you the precise mechanical and physical properties needed for your most exacting requirements.

The Brush Beryllium Co. and its Pennrold Division offers you the world's most completely integrated facilities for the production of beryllium copper strip with metallurgical properties tailored to the needs of individual customers. With it, you get complete application and fabrication field engineering service, the widest range of sizes (down to 0.0005" thick) and the largest coil size in the industry (for greater uniformity and faster delivery).

The same precise metallurgical control and complete field engineering service is also available to users of precision rolled phosphor bronze and other special purpose alloy strip.

For more information, quotations, or fast delivery—call your nearest Pennrold Service Center, today!



PENNROLD DIVISION
501 Crescent Avenue/Reading, Pennsylvania

Service Centers and Warehouses

Reading, Pa.— FRanklin 5-4361
Southington, Conn.— MArket 8-5574
New York, N. Y.— WAlker 5-7500 or Enterprise 6479
West Paterson, N. J.— CLifford 6-1085
Philadelphia, Pa.— MOhawk 4-6749
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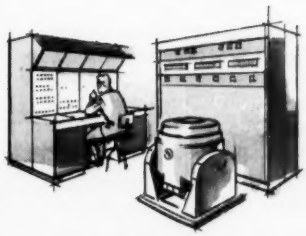
Chicago, Ill.— GLadstone 5-7850
Detroit, Mich.— TUxedo 4-2530
St. Louis, Mo.— SHerwood 1-6423
Greensboro, N. C.— BRoadway 3-5973
Los Angeles, Calif.— PLeasant 3-5531

Circle 563 on Page 19

TWENTY million watts—that's the cumulative output available from MB power supplies now driving vibration test systems in the field.

The figure is more than a measure of the new importance of vibration testing. It's a measure of MB's technical advancement in the field of electronics for vibration, acoustics, and sonar.



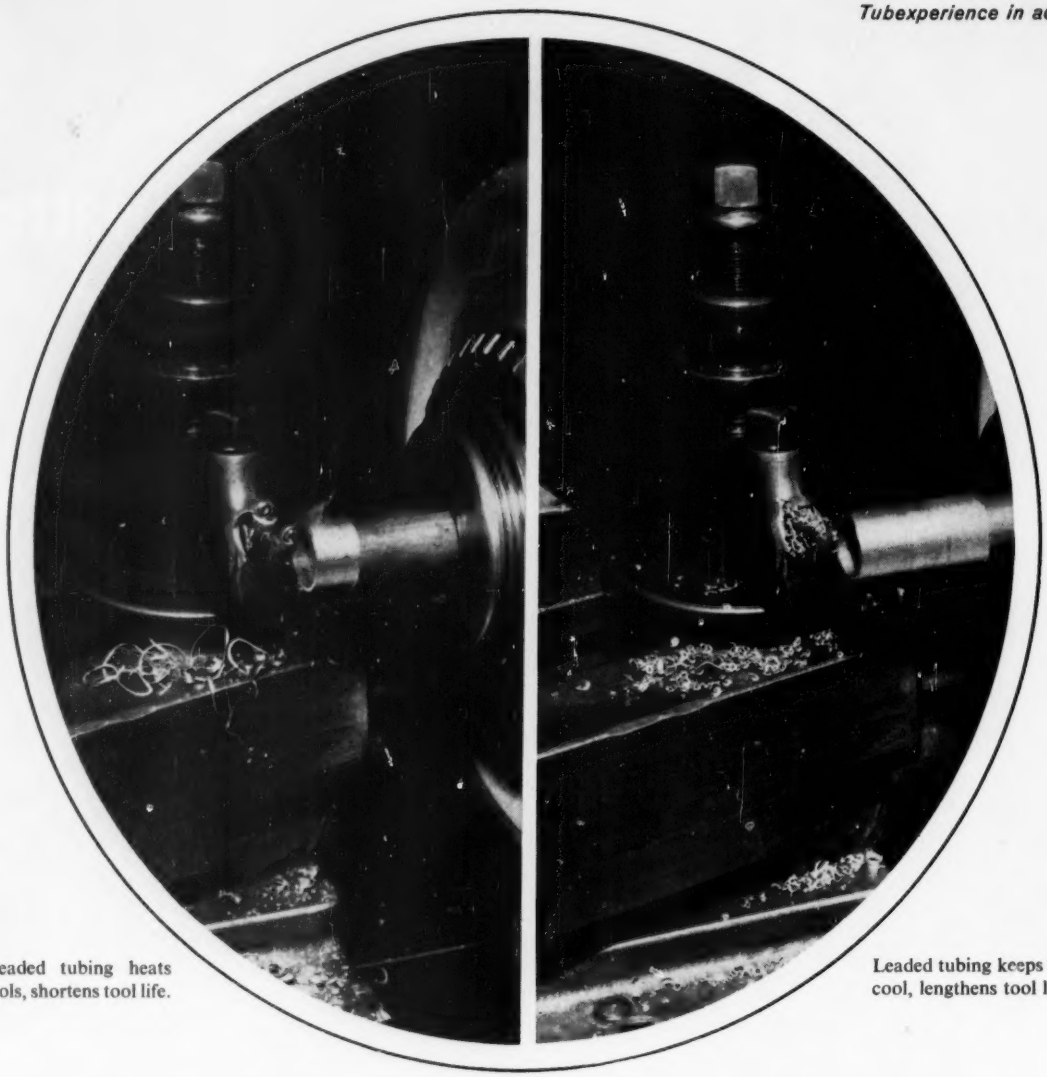
Pioneer and leader in the field of vibration

And it's a measure of the company's unequalled background of experience in designing electronic power for dynamic forces... in producing *integrated* vibration testing systems including amplifiers of 100KW output and more, and exciters that utilize amplifier power more efficiently... in programming vibration tests to any required specification. This experience is available to you through MB's staff of vibration specialists and the largest force of field service technicians. Avail yourself of their expert recommendations on your vibration test problems.

MB ELECTRONICS

A DIVISION OF TEXTRON ELECTRONICS, INC., 1056 State Street, New Haven 11, Conn.

Circle 564 on Page 19



Nonleaded tubing heats up tools, shortens tool life.

Leaded tubing keeps tools cool, lengthens tool life.

Now Superior Carbon Steel Tubing with Built-in Lubrication

New leaded 1020 tubing permits faster speeds and heavier feeds, often reduces the number of finishing operations

Where machinability is of major importance, specify Superior Seamless Leaded 1020 Tubing. Its built-in lubrication permits faster speeds in turning, drilling, tapping, milling, grinding and other machining operations, provides an 18% increase in feeds, and often reduces the number of finishing operations required to produce a smooth, lustrous surface. Build-up of metal at the cutting edge of the tool is minimized. Chip formation is improved. Tools operate at lower temperatures, last longer, and require fewer dressings. Lower tool cost is an accompanying benefit. Another is reduced downtime for replacement of dull and wornout tools. There is virtually no difference in physical and mechanical properties between leaded and nonleaded carbon steel tubing. So the grades are interchangeable.

Superior Seamless Leaded 1020 Tubing is available in a range of ODs from .012 through 1⅛ in. For particulars, send for Data Memorandum No. 24. And remember that other small-diameter tubing is available in more than 120 analyses, meeting a very broad range of applications. Superior Tube Company, 2010 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

All analyses .010 in. to ⅝ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company, Los Angeles, California • FIRST STEEL TUBE MILL IN THE WEST

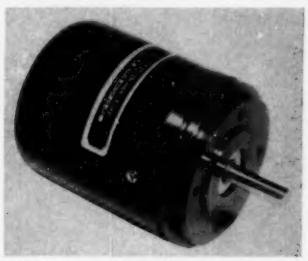
Circle 565 on Page 19

eral-purpose phenolic; they are also supplied in plastics per MIL-M-14E for military applications. Top and bottom are closed with molded plastic so that no live metal is exposed. Wires are inserted from both sides of block, and center bridge prevents wire leads from going all the way through. Wires can be disconnected from either side, while wires on opposite side remain connected. Blocks are available in any length from two to 12 terminals. **Kulka Electric Corp.**, 633-643 S. Fulton Ave., Mt. Vernon, N. Y. D

Circle 789 on Page 19

Limit-Stop Assembly

has range of limits from 30 to 4530 deg



X2 compact, heavy-duty limit-stop assembly is made to MIL-Specifications and is available in both ball-bearing and oilless bronze-bearing types. Range of mechanical stop limits is from 30 to 4530 deg. Unit is self-adjustable for fine zero adjustment, and is good for stopping torques to 500 oz-in. **PIC Design Corp.**, 477 Atlantic Ave., East Rockaway, L. I., N. Y. D

Circle 790 on Page 19

Power Control Unit

uses solid-state thyratrons

Standard power control unit is a small, chassis-mounted device which requires only power and load connections. It can be controlled in an open or short-circuit mode of operation from a variety of signal sources. Unit utilizes solid-state thyratrons and own control amplifier. It is suitable for applications where adjustable voltage (dc or ac power) is required, for dc motor speed control, heat control in industrial furnaces, and theatrical lighting systems. Unit controls up

Specify
BIJUR
AUTOMATIC LUBRICATORS
For
DESIGN, SERVICE AND RESEARCH
are part of every Bijur System

Consider Service—Bijur Field Engineers work hand in hand with machine builders to custom design a Bijur system which will amply meet the needs of the machine for automatic lubrication.

How you benefit—Whether you are a designer, purchasing agent, or plant engineer, you'll see substantial savings when you have Bijur Systems in the equipment you own and manufacture. Custom designed, Bijur Systems are easy to install, reduce down-time and repair bills, increase production, eliminate costly hand oiling. There's no chance for product spoilage due to over-lubrication, Bijur Systems deliver the right amount of metered oil to every bearing, *when it's needed.* Costly hand oiling is eliminated.

Write today for all the facts on how Bijur Systems can solve your lubricating problems.

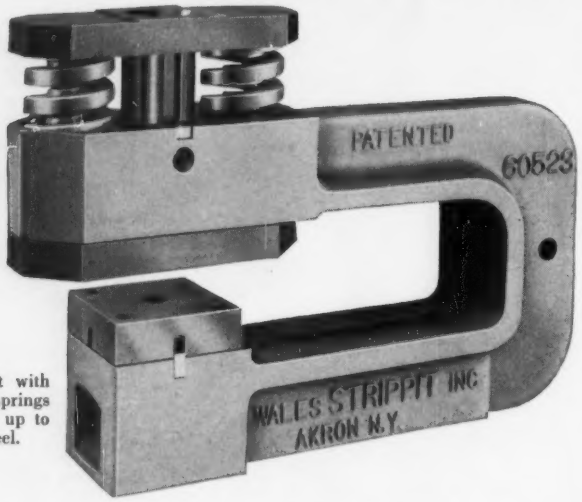
BIJUR AUTOMATIC LUBRICATORS—STANDARD EQUIPMENT IN MANY INDUSTRIES
Machine Tools • Business Machines • Printing Machinery • Textile Machinery • Food Product Machines • Bottling Machines • Packaging Machines • Sheet Metal Machines • Plastic Fabricating Machinery • Glass Products Machinery • Wood-Working Machinery • Industrial Sewing Machines • Special Process Equipment

BIJUR
LUBRICATING CORPORATION
Rochelle Park, New Jersey
Pioneers in Automatic Lubrication
4345

Circle 566 on Page 19

new STRIPPIT PUNCHING UNITS

with DUAL-RANGE capacity!



● Strippit unit with mechanical springs for piercing up to .500 mild steel.

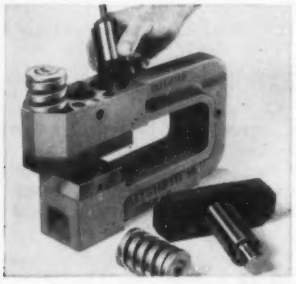
- Up to .500 mild steel, using removable Strippit mechanical springs
- Up to .750 mild steel, with interchangeable Strippit Hydra-Springs
- Convertible from .500 to .750 capacity in seconds, at minimum cost
- One heavy-duty holder for both capacity ranges
- Readily replaceable punch tips and dies—round, obround, square, shaped
- Keyed punch body keeps punches accurately aligned

USING STRIPPIT MECHANICAL SPRINGS

Max. punch dia.	Max. material thickness (mild steel)
1.375	.250
1.250	.375
1.125	.500

USING STRIPPIT HYDRA-SPRINGS

Max. punch dia.	Max. material thickness (mild steel)
1.375	.375
1.250	.500
1.125	.625
1.000	.750



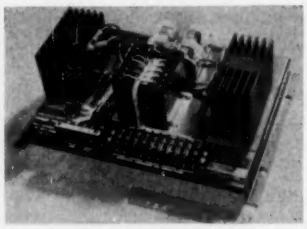
◀ Mechanical springs are easily replaced with Hydra-Springs for punching up to .750 mild steel.

WRITE TODAY for the new Strippit General Catalog. It covers all details on this and all other Strippit units... plus the savings in tooling and press time effected with the famous cost-cutting Strippit System of fabrication.

WALES STRIPPIT INC.
216 Buell Road • Akron, New York

A UNIT OF HOUDAILLE INDUSTRIES, INC.

Manufactured in Canada by: Strippit Tool & Machine Company, Brampton, Ont.



to 3 kw, and provides complete solid-state system from logic input to power-handling output. High efficiency of thyratrons permits application at extremely high levels. Most of input becomes usable output. **Control Div., Magnetics Inc.,** Butler, Pa. F

Circle 791 on Page 19

Epoxy Sheet

for electrical and electronic uses

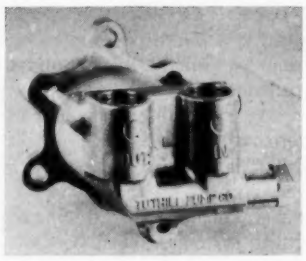
Repox epoxy sheet is used to make headers, strips, panels, mounting boards, and shells for use when encapsulating components in epoxy resin. Sheet is available in 8 x 8 and 12 x 12-in. sizes with nominal thicknesses of 1/16, 1/8, 3/16, 3/8, and 1/2 in. Other thicknesses and sizes are available to order. Normally stocked in standard colors of black, red, blue, green, and yellow, sheet can be supplied in other colors also as required. **Republic Plastics Corp.,** 2 Hixon Place, Maplewood, N. J. D

Circle 792 on Page 19

Water Pump

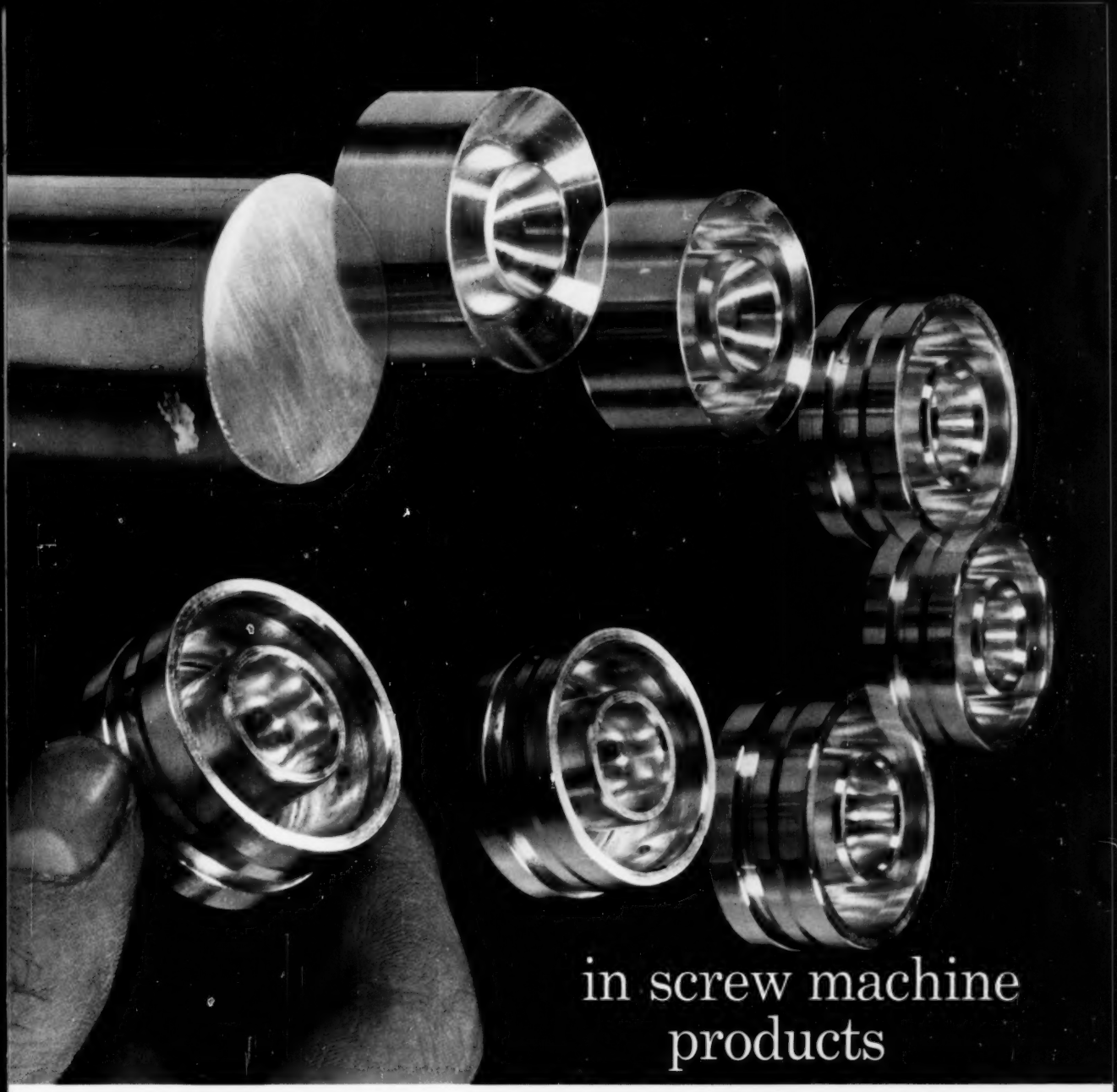
for capacities from 35 to 95 gph

Model T water pump, available in four different models, is rated for capacities from 35 to 95 gph at 100 psi differential, with rated speed of 1725 rpm. A vane-type pump, it features stainless-steel and graphite construction. Developed particularly



Circle 567 on Page 19

Circle 568 on Page 19→



Alcoa puts the metal where you want it

This aluminum piston for an automotive air-conditioning compressor shows how far Alcoa goes to put the metal where you want it. Not just in primary screw machine operations, complex and demanding as they were, but on through a series of exacting secondary operations that enabled us to deliver a completely finished part.

Using 1 1/16-in. diameter 2014-T4 cold finished bar on a six-spindle automatic, we handled the forming, trepanning, drilling, facing and counterboring. Then we tackled the rest of the job—drilling and deburring two 1/16-in. cross holes. This was followed by coining the ball seat at a specified tonnage in order to insure proper assembly without distortion. Centerless grinding was then performed to a total tolerance of half a thousandth of an inch (plus or minus 0.00025 in.). All finished? Not by our standards. After final inspection, we cleaned every piece and packed it with meticulous care to prevent damage in transit, insuring safe and sound arrival.

Whether it's screw machine parts, forgings, castings, extrusions or impacts, Alcoa can put the metal where you want it—precisely and economically. The payoff may be fewer rejects, new flexibility in design, less waste in production, a best-selling product—or all four. To draw on Alcoa's file of ideas and Alcoa facilities, write today: Aluminum Company of America, 920-K Alcoa Building, Pittsburgh 19, Pa.

Alcoa puts the metal where you want it—in castings, forgings, impacts, extrusions and screw machine parts.

ALCOA ALUMINUM

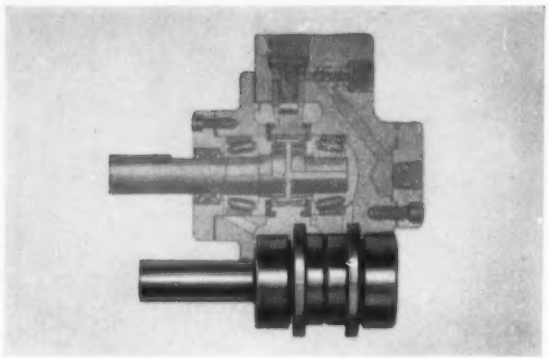
ALUMINUM COMPANY OF AMERICA

For exciting drama watch "Alcoa Presents" every Tuesday, ABC-TV, and the Emmy Award winning "Alcoa Theatre" alternate Mondays, NBC-TV

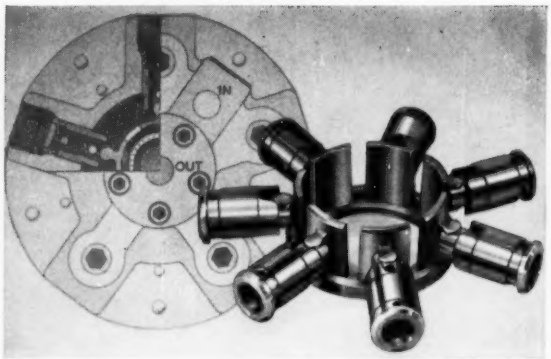
Your Guide to the Best in Aluminum Value

FOR PRESSURES TO 5,000 PSI . . .

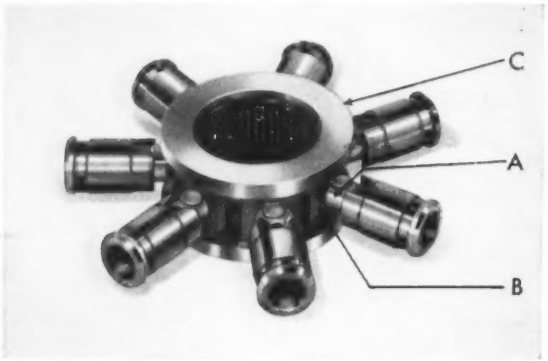
Only the AE Hydramite gives you these 4 key benefits



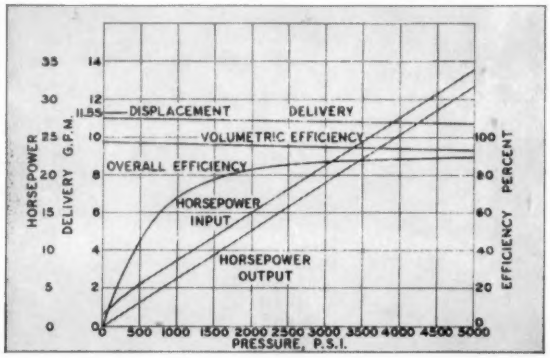
1. Tapered roller bearings. Two high capacity, heavy duty tapered roller bearings support the eccentric cam shaft. This means that a Hydramite can take more punishment . . . handle heavier unbalanced loads . . . and last longer. The pump casing is ported so that the pumping action of tapered bearings will provide better lubrication.



2. Curved slippers riding on the outer race of the cam shaft needle bearing minimizes scrubbing action between these parts. They also distribute thrust loads of the plungers and reduce unit stresses to the point where maintenance will never be required at what is a critical wear point in most hydraulic pumps.



3. Positive pumping action. The Hydramite has no cam follower springs to fail. Plungers (A) are connected to curved slippers (B) which are held against the outer race of cam shaft needle bearing by two plunger return rings (C). As the shaft revolves, each plunger is pushed outward in succession and then pulled back by the return rings.



4. High efficiency. With a Hydramite you get an overall efficiency of 85%. Shown above is typical 10 gpm pump curve. Its flat overall high efficiency has little variation between 1,500 and 5,000 psi. What's more, with a Hydramite you get positive suction. There is no need for supercharging equipment which reduces system efficiency.

To meet your specific requirements, Hydramite pumps can be supplied for constant displacement from 3 to 30 gpm at 5,000 psi and 70 to 85 gpm at 3,000 psi for hydraulic fluids with viscosities of 150 to 300 ssu at 100° F. In special applications they have handled viscosities as low as 40 and as high as 900 ssu at 100° F.

Special materials and seals permit handling of missile fuels and special fluids at higher temperatures. Available in flange, foot or face mounted styles. Write or call American Engineering Company, Dept. P-147, Philadelphia 37, Pa. Phone: CUmberland 9-3800.

AMERICAN ENGINEERING COMPANY

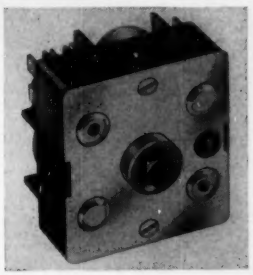
Hele-Shaw Pumps, Lo-Hed Hoists, AE Marine Deck Auxiliaries, Vibra Grate, Perfect Spread and Taylor Stokers.

for drink-vending machine and carbonator service, it can be used for other water-pump requirements in its range, and can also be provided with suitable modifications for use with many other fluids. Unit can be provided with either right or left-hand inlet, with or without built-in relief valves, and with or without built-in by-passes. Several alternate shaft extensions are also available. **Dept. RP, Tuthill Pump Co.**, 939 E. 95th St., Chicago, Ill. J

Circle 793 on Page 19

Interval Timer

is nonadjustable, pushbutton-actuated type



Series AT-35 interval timer is a totally enclosed, motor-driven switching device for use in control of vending machines, hand dryers, and photocopying equipment. It allows repetitive actuation of a factory-set interval by means of a pushbutton and eliminates necessity of hand selection. Timing interval is initiated by manually setting to a selected interval. At completion of interval, switch opens, de-energizing load and timing motor. Molded phenolic housing offers a rigid, dusttight construction that assures reliable performance under adverse ambient conditions. Switch is rated at 28 amp or 1 hp at 250 v ac. Timer is available for 120 or 240-v operation at 50 or 60 cps with any interval from 2 sec to 120 min. **Haydon Div., General Time Corp.**, 245 E. Elm St., Torrington, Conn. B

Circle 794 on Page 19

Limit Switch

operates at speeds to 300 rpm

Rugged rotary-cam limit switch with 2 to 16 individual circuits op-

SEALING DOMESTIC APPLIANCES IS A REAL CHALLENGE, TOO!
Standard 6A Seal with specially designed seat conforming to impeller contour so as to promote good water flow characteristics.
Limited axial room and large diameter are mechanical requirements in this washing machine seal. Design features multiple spring construction for even face loading.
FIVE ADAPTATIONS OF THE John Crane® TYPE 6A SEAL for four different appliance manufacturers
Seal features outer periphery face construction to best service garbage disposal conditions.
Two sealing points in a washing machine with widely differing physical limitations, yet seals for both retain full advantage of diaphragm action, shouldering points and positive drive.

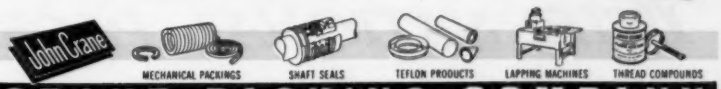
Soapy water, detergents, bones, grit and lint . . . all these combine to make appliances a hard-to-handle sealing problem. Add that to a very limited space factor, and you've got a real set of conditions on your hands.

"John Crane" engineers have solved these problems and thousands of other shaft sealing applications on all types of commercial and industrial equipment. We know that we can be of the same help to you.

That's why . . . as one design engineer to another . . . we urge you to let us work with you in adapting or developing the proper seal for your application.

Tell us about your requirements or write for our fully illustrated Bulletin S-204-3 on "John Crane" Shaft Seals.

Crane Packing Company, 6425 Oakton Street, Morton Grove, Illinois, (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*



Circle 570 on Page 19

HIGH WALLED ?

How long since you have re-evaluated the wall height on your cup packings? Frequently IPC encounters "prints" which call for excessive wall height . . . *and* this extra depth can cause headaches.

Unnecessary wall height can only add to friction and make your cups run "hotter" . . . Torque increases . . . Toe-in is enhanced. Unless there is some unusual factor involved, IPC can recommend a more functional design without these built-in hazards.

Elaborate hide selection combined with IPC "custom treats" and IPC's square shouldered design mean your leather packings and oil seals are started "right". For the finishing touch, IPC offers the last word in quality controlled manufacture.

Let us analyze your leather packings. Perhaps we can tailor a design that will fit your application perfectly.

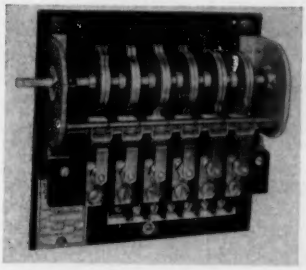
OIL SEALS
PACKINGS
PRECISION MOLDING
Custom designed
. . . for your application

IPC

INTERNATIONAL PACKINGS CORPORATION

Bristol, New Hampshire

P5



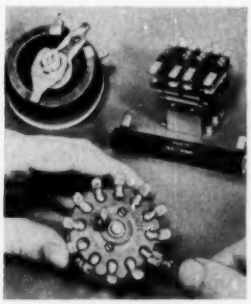
erates at speeds to 300 rpm with no observable wear. Components contributing to the heavy-duty construction include large, ⅜-in., coin-silver, nonflexible contacts rated conservatively at 15 amp, ball-bearing-supported cam shaft, nylon roller cam followers, and 2-in. diam nickel-plated cams which assure accuracies to ½ per cent. The ¼-in. cam shaft extends beyond bearing mounting for connection to external drive. **Eagle Signal Co.**, 202 20th St., Moline, Ill. I

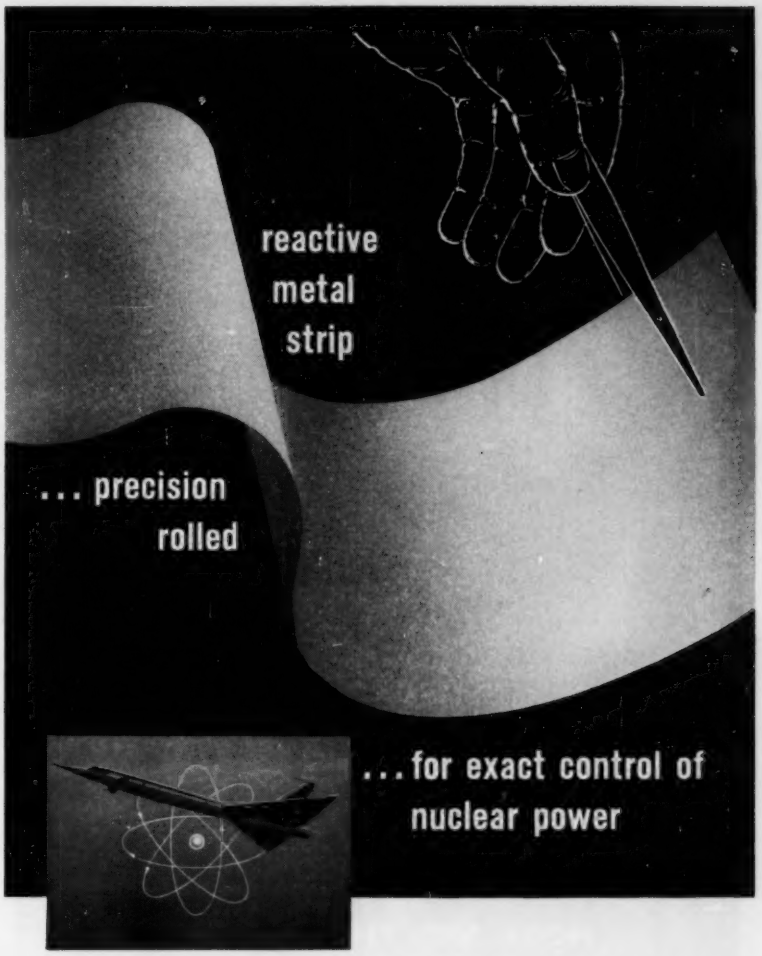
Circle 795 on Page 19

Quick-Connect Terminals

are provided on many components

Quick-connect, push-on type terminals are specially shaped tabs to which leads can be connected quickly by means of commercial quick-connect female connectors. They are provided on many tap switches, power resistors, power rheostats, relays, and variable transformers. Female connector is pushed onto, and slides over, tab terminal. Fangs on connector score tab to assure good electrical contact, and a projection snaps into a hole in tab to secure connection. Leads can be attached to terminals more rapidly than with soldering. Units can also be used where a sequence of connections must be periodically modified or where accessibility for





The vital need for uncommon **new** metals for nuclear applications is being met today by Precision Metals Division of Hamilton Watch Company. Now, even reactive and refractory metals such as Hafnium, Zircaloy, Tantalum, Columbium and Titanium can be obtained in any form—from ingot to ultra-thin strip and foil —in production quantities.

The newly expanded and completely integrated facilities of Precision Metals Division are geared to produce ultra-thin strip and foil in any quantity and in a wide range of alloys, with these special advantages:

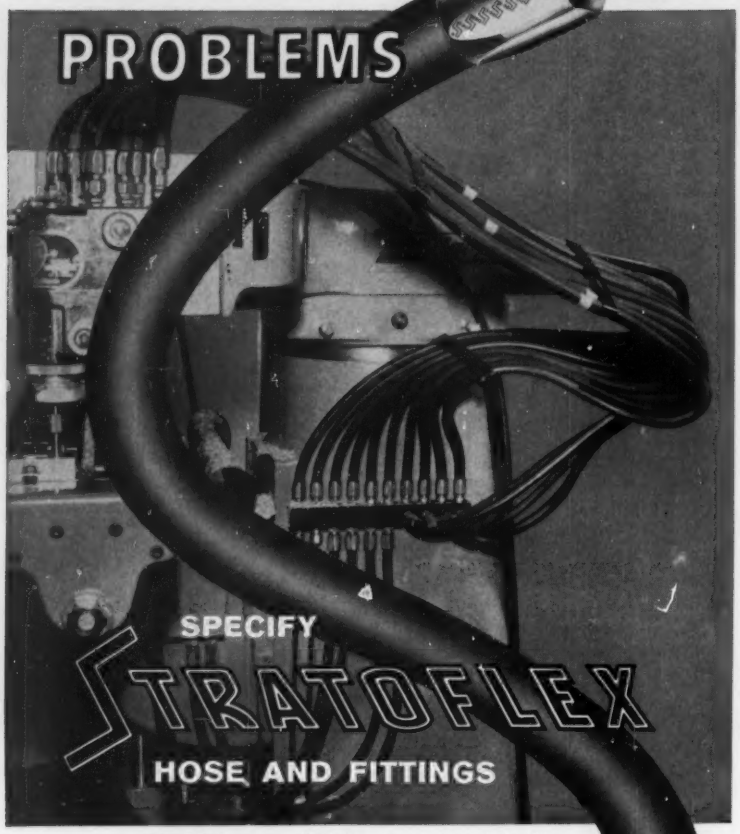
thicknesses from .010" to .0001"
extremely close tolerances
dimensional uniformity
controlled metallurgical properties
excellent surface characteristics

For special requirements in development or production, Precision Metals can also furnish special alloys to your own specifications in the form you need. Write today for fully illustrated facilities booklet **MD-12.**

HAMILTON
WATCH COMPANY / **Precision Metals Division**
Lancaster, Pennsylvania

Circle 572 on Page 19

SOLVE DESIGN and MAINTENANCE PROBLEMS



SPECIFY STRATOFLEX HOSE AND FITTINGS

Stratoflex was specified for the precision hydraulic tracing control kit on this tool room milling machine.

When you design with Stratoflex you get more than the vibration and stress resistance inherent in flexible hose. You get hose fittings designed to meet your specific requirements. And with Stratoflex leak-proof reusable fittings you simplify maintenance by making possible quick, easy replacement or modification. You solve both design and maintenance problems when you specify Stratoflex.

Write for Bulletin S-2 today

SF10-9

STRATOFLEX Inc.

P.O. Box 10398 Fort Worth, Texas
Branch Plants: Hawthorne, Cal., Fort Wayne, Toronto
In Canada: Stratoflex of Canada, Inc.

SALES OFFICES:
Atlanta, Chicago
Cleveland, Dayton
Detroit, Fort Wayne
Fort Worth, Hawthorne
Houston, Kansas City
Milwaukee, New York
Philadelphia, Pittsburgh
San Francisco, Seattle
Toronto, Tulsa

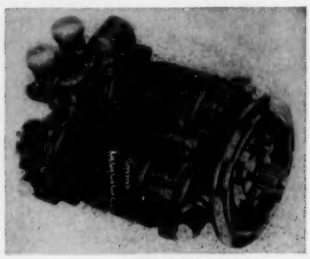
service is important. Tabs are ordinarily ¼ in. wide, but 3/16-in. tabs can also be supplied. **Ohmite Mfg. Co.**, 3653 Howard St., Skokie, Ill. J

Circle 796 on Page 19

Hydraulic Piston Pumps

accommodate fluid temperature to 550 F

Dual-element pumps, designated Model 013673-010, are for use in high-pressure, high-temperature aircraft-engine main hydraulic systems. Design incorporates two independent pumping elements within a single body, both driven by a common driveshaft. Positive protection against failure is afforded



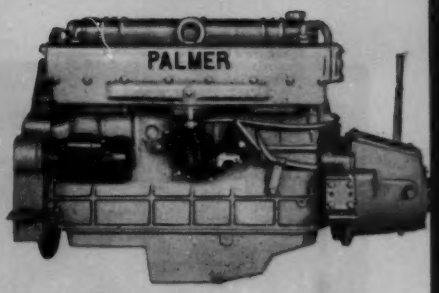
by twin pump elements, each of which is capable of supporting full system pressure demands. Hydraulic system pressures to 4000 psi full flow, with fluid temperatures to 550 F, are maintained with complete reliability. Pump operating speed of 5750 rpm can be developed from a wide range of take-off drive speeds, making unit adaptable to many different aircraft-engine systems. **Pesco Products Div., Borg-Warner Corp.**, 24700 N. Miles Rd., Bedford, Ohio. F

Circle 797 on Page 19

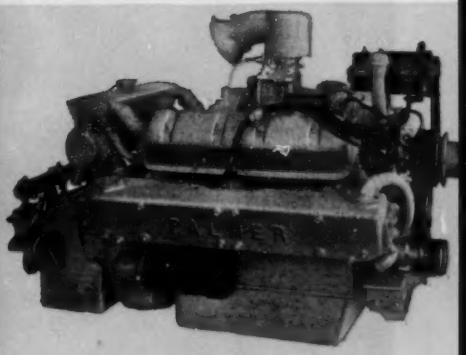
Glass-Epoxy Laminate

retains strength at 300-F temperature

GEC-111 glass-base, epoxy-resin laminated plastic meets specifications for NEMA Grade G-11 and military grade MIL-P-18177B-Type GEB. It is for use in both normal and elevated-temperature applications to 300 F. Ability to retain strength at elevated temperatures makes material particularly suitable for use as base material for copper-clad laminated plastics. Excellent



This 32-ft. custom built cruiser has a 28 mph. top speed. Power is provided by pair of International 6-cyl. engines with 264 cu. in. displacement.



Big sightseeing boat makes 30 minute full throttle trips at 30 mph. Power: two International UV-461 V-8 engines shown above.

R. C. Bolling, President, the Palmer Engine Co., Cos Cob, Conn.

"Sales up over 500% in five years after switch to International power"

Here's the full report on the experience of a 72-year-old company in search of ideal power as related by President R. C. Bolling:

"As the oldest marine engine manufacturer in the country, The Palmer Engine Co., has progressed from construction of complete marine engines in small volume to the present-day utilization of mass-produced engine assemblies adapted to marine purposes in order to bring the boating public highly engineered, economical marine engines to suit current boating requirements.

"In this process of evolution, Palmer has used a number of mass-produced industrial and automotive assemblies, but we never experienced such success as that which came our way after we began using International engine assemblies five years ago. Our sales have increased over 500% in five years and the boating public, both commercial and pleasure, has come to know that an International-Palmer marine engine means the utmost in power, dependability and economical operation. We look forward to the future with confidence that our International marine engine sales will re-double many times and that our International diesel marine sales will soon become a big factor in the industry."

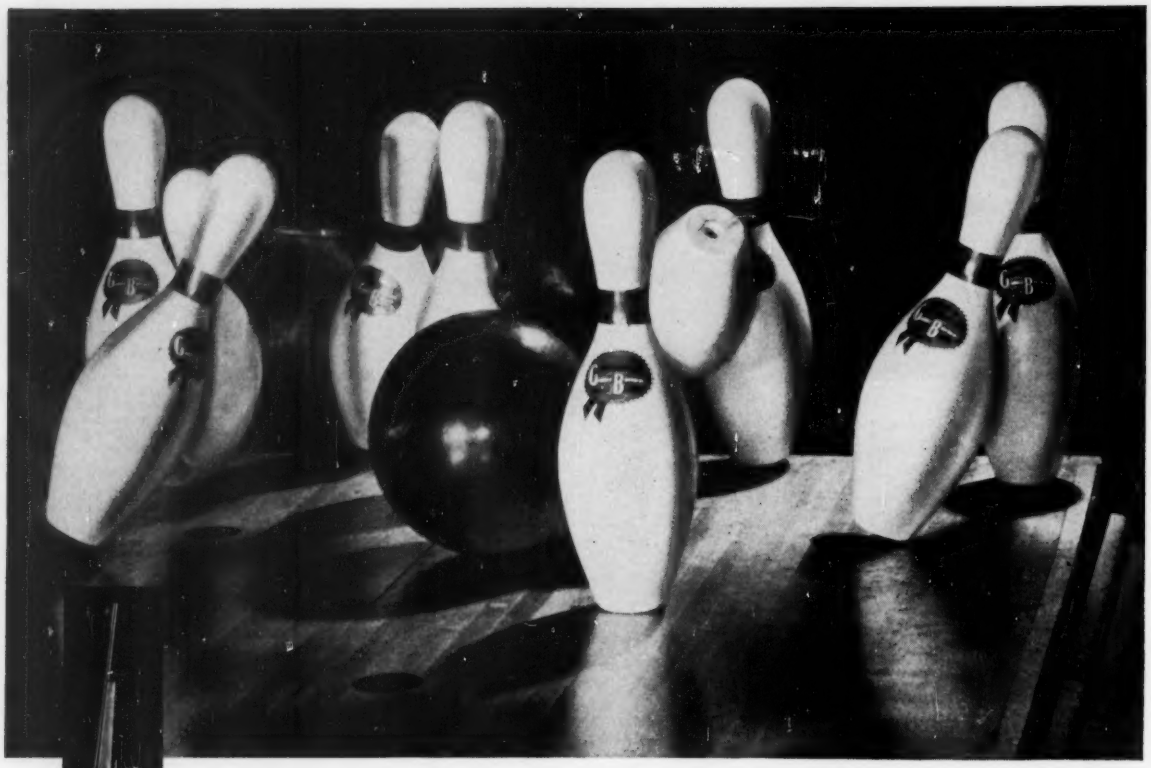
See the Palmer exhibit at the National Motor Boat Show, New York Coliseum, January 13-24, and call or write International Harvester Co., Engine Sales Dept., Construction Equipment Division, Melrose Park, Illinois, for information about this outstanding 24-model engine line. Power range is 16.8 to 385 max. hp, diesel or carbureted.

INTERNATIONAL®
ENGINES

International Harvester Co., 180 N. Michigan Avenue, Chicago 1, Illinois

A COMPLETE POWER PACKAGE: Crawler and Wheel Tractors... Self-Propelled Scrapers and Bottom-Dump Wagons... Crawler and Rubber-Tired Loaders... Off-Highway Haulers... Diesel and Carbureted Engines... Motor Trucks... Farm Tractors and Equipment.

Circle 574 on Page 19



from rifle stocks...to bowling alleys...

GAMBLE solves problems with WOOD!

Marksmen found that the slightest swelling or shrinking of their rifle stocks reduced firing accuracy. To solve the problem, a custom gunstock manufacturer turned to Gamble Brothers. Result: a laminated gunstock blank with greater dimensional stability, less tendency to warp, greater strength, and freedom from internal stresses.

To the pioneer producer of laminated pins — Gamble Brothers — came another problem from the bowling industry: need for ball return upsweeps and downsweeps on which the ball would not skid, then stop halfway back. Result: a laminated track which is stronger, takes less wood — and with proper friction factor for conveying ball back to bowler.

Design problems like these are "all in a day's work" to the wood engineers at Gamble Brothers — a unique organization designing and building a wider variety of wood products than any other U. S. woodworking company. Today they're working in three principal areas: (1) improvement of present wood products (2) development of new wood products (3) product development in combinations of wood and other materials.

Why not present *your* design or component problem to Gamble Brothers? WOOD may be the answer!

FREE booklet illustrates GAMBLE services

This 28-page booklet describes Gamble facilities and services in detail. Includes many photographs of unusual products designed, tested and perfected by Gamble Brothers. Write for your copy today! Gamble Brothers, Inc., 4619 Allmond Ave., Louisville, Ky.

If the problem involves wood, Gamble can help!

GAMBLE BROTHERS GB GUARANTEED BOND

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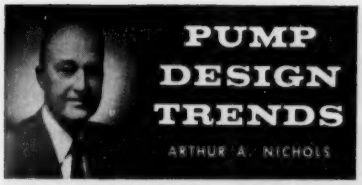


Machine designers eliminate complete pumps with "designed-in" pumping elements for many applications

A three-piece insert package *(Fig. 1.)* makes this economical pump integration possible. Consisting of an inner and outer Gerotor and an eccentric locator-ring, the unit becomes a complete pump by simply boring the casting or frame of the mechanism to accommodate the locator ring O.D. and by providing porting. This design makes the main casting do double duty as the pump housing, thus eliminating a very considerable cost factor. A drive can be taken from any convenient shaft.,

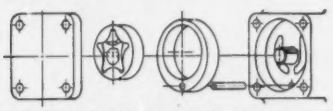


Fig. 1. Three Gerotor components permit pump to be incorporated as integral part of housing or frame of mechanism, eliminate need for purchase and mounting of separate, complete pump.

Designers of engines, compressors, machine tools, tractors, transmissions and other equipment requiring hydraulic systems can now build pump components integrally into these mechanisms — at a fraction of the cost of complete, separately purchased pumps.

A wide variety of sizes is available covering capacities up to 100 gpm and 1,000 psi. Unlike complete pumps, the inserts are extremely flexible in adapting to various mechanism geometries.

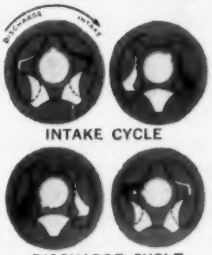


FIG. 2

The resulting pump is a self-priming, positive-displacement, lightweight, valveless mechanism. It is long-wearing, and handles impurities in the fluid well. It can be made to pump in the same direction regardless of direction of rotation. It provides a relatively pulseless flow: volumetric and mechanical efficiencies are high; it is balanced and quiet in operation. *(Fig. 2.)*

The Nichols insert-package eliminates mounting pads, couplings, connectors, accessory drives and similar costly items and does away with buying finished pumps. Our technical assistance is available to you at all times and you are cordially invited to write for specific information on how this new concept can be adapted to your current designs.

W. H. NICHOLS CO.
Woerd Ave., Waltham 54, Mass.

Circle 576 on Page 19

strength retention also suits it for use wherever high ambient temperatures are encountered, such as might occur in miniaturized, enclosed components. Maximum heat resistance for continuous use is 350 F. Material combines extremely high flexural, impact, and bonding strength with low moisture absorption and excellent chemical resistance. It exhibits low dielectric losses and good insulation resistance even during exposure to high humidity. Laminate is furnished in sheets only in thickness range of 0.01 to 1 in. **Taylor Fibre Co.**, Norristown, Pa. E

Circle 798 on Page 19

Winding Tube

of bonded glass cloth and mica mat

Class H winding tube combines high dielectric characteristics with excellent mechanical strength and ease of handling. Made of silicone-bonded glass cloth and mica mat, it resists high temperatures and has low moisture absorption. There are no sharp corners to cut or abrade wires, and tube is easily trimmed to size. Tube is available in sizes from 3/16 x 3/16 to 10 x 10 in. Square, rectangular, and round tubes are offered. **Accurate Paper Tube Co. Inc.**, 806 N. Peoria St., Chicago 22, Ill. J

Circle 799 on Page 19

Circuit Breaker

is only 3 in. wide

Stab-lok three-pole, 100-amp circuit breaker is one-third the size of comparably rated breakers available. Only 3 in. wide, it is dual rated for use as a plug-in main circuit breaker in a standard three-

ISOMODE® PADS

shaped for vibration isolation at low cost

MB ISOMODE Pads cut vibration transmission, soften impact shock, sharply reduce maintenance due to vibration. Developed for a wide range of shock and vibration absorption assignments, they're being used instead of costlier, custom-designed rubber mounts or steel springs.

One designer, for example, was troubled with difficulties in matching stiffness, or K factor, of helical springs used to absorb pulsations of a long, vibrating conveyor. Replacing them with several plies of ISOMODE Pads gave excellent results. And adding or subtracting a ply permits full field control over resilience.

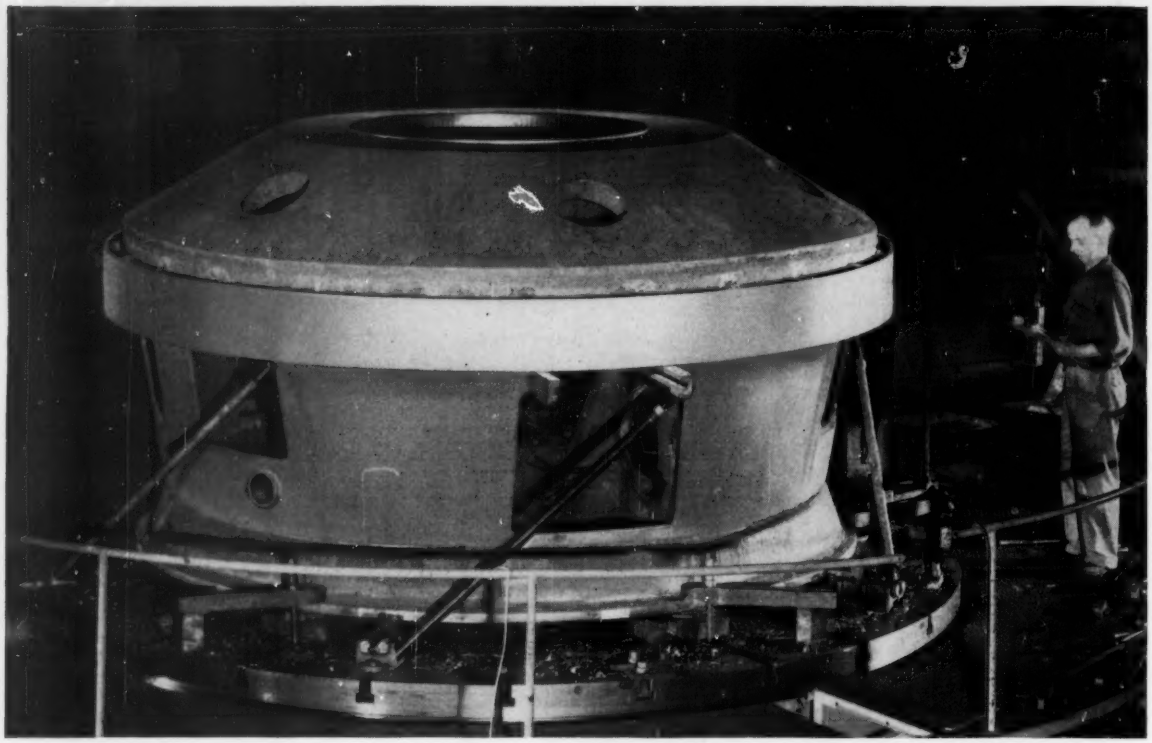
ISOMODE Pads can be supplied in specified shapes. They are ¾" thick neoprene, ribbed on both sides, come in various durometers, have as much as 50#/ in² load capacity. Send for more data.

MB ELECTRONICS
A DIVISION OF TEXTRON ELECTRONICS, INC.
1056 State Street, New Haven 11, Conn.

Pioneer and leader in the field of vibration

Circle 577 on Page 19

STEEL-WELD FABRICATION . . .



PRECISION WELDMENTS

Fabricated and Machined to Specification!

The 16-Ton Weldment above, undergoing machining operations, is one of several components of a radar antenna's base mechanism. This piece is typical of thousands of Steel-Weld Fabricated parts and assemblies produced and machined to specification by Mahon for defense contractors, manufacturers of processing machinery, machine tools, and other types of heavy mechanical equipment.

When your design calls for weldments of any kind, you, too, will want to discuss your requirements with Mahon engineers; because, in the Mahon Company you will find a unique source for weldments or welded steel in any form . . . a fully responsible source with a long and enviable performance record, and unusual facilities for design engineering, fabricating, machining and assembling.

See Sweet's Product Design File for information on Facilities, or have a Mahon sales engineer call at your convenience.

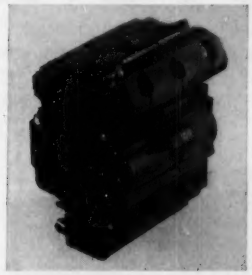
Use WELDED STEEL for 100% Predictability and Greater Strength with Reduced Weight!

THE R. C. MAHON COMPANY • Detroit 34, Michigan

SALES-ENGINEERING OFFICES in DETROIT, NEW YORK, CHICAGO, LOS ANGELES and SAN FRANCISCO

MAHON

Circle 578 on Page 19



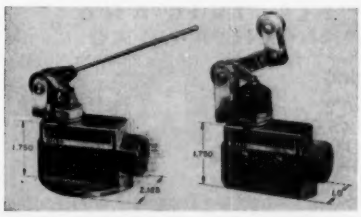
phase load center, or as a branch breaker in either a load center or NALP panelboard. Connectors are approved for copper or aluminum conductors. Switch has improved thermal-magnetic trip action, allowing thermal element to trip breaker on prolonged overloads, but eliminating nuisance tripping due to harmless overloads. Fast magnetic action trips breaker when dangerous short circuits occur. Wiping dual-brake contact structure splits up arc for instant extinction. **Federal Pacific Electric Co.**, 50 Paris St., Newark 1, N. J. C

Circle 800 on Page 19

Enclosed Switches

have roller arm and rod actuators

E6 and V6 easy-to-wire enclosed switches are available with one-way roller-arm and rod actuators. One-way roller-arm actuators that provide electrical actuation in one direction only are available for either side or bottom mounting. They are for use with machine tools employing a slide to actuate switch and override it, but not to actuate it on return stroke. Sealed plunger protects actuating mechanism and switching unit from dirt and splashing liquids. Side and bottom-enclosed switches, also available, are furnished with a low-force, 6-in. rod actuator. They are used with counters, conveyors, and sorting devices. Rod can be cut or formed to meet individual requirements.



Mine too...

That's right, Lois. Mom says Dad told her that he and your Dad decided to quit trying to make gears for their machines . . . better to buy them from a gear maker. Now he's not glowering around, mumbling about "costs" anymore. Let's send that CINCINNATI man a really cool record album!

CINCINNATI gears cut your costs ALL the way—
Precision inspection saves your in-plant checking costs . . . Guaranteed delivery dates cut production delays . . . Consistent quality reduces assembly costs . . . High machine utilization means lower gear prices to you.
Send prints for quotation on your gears and custom gear boxes.

CINTI®

THE CINCINNATI GEAR CO.

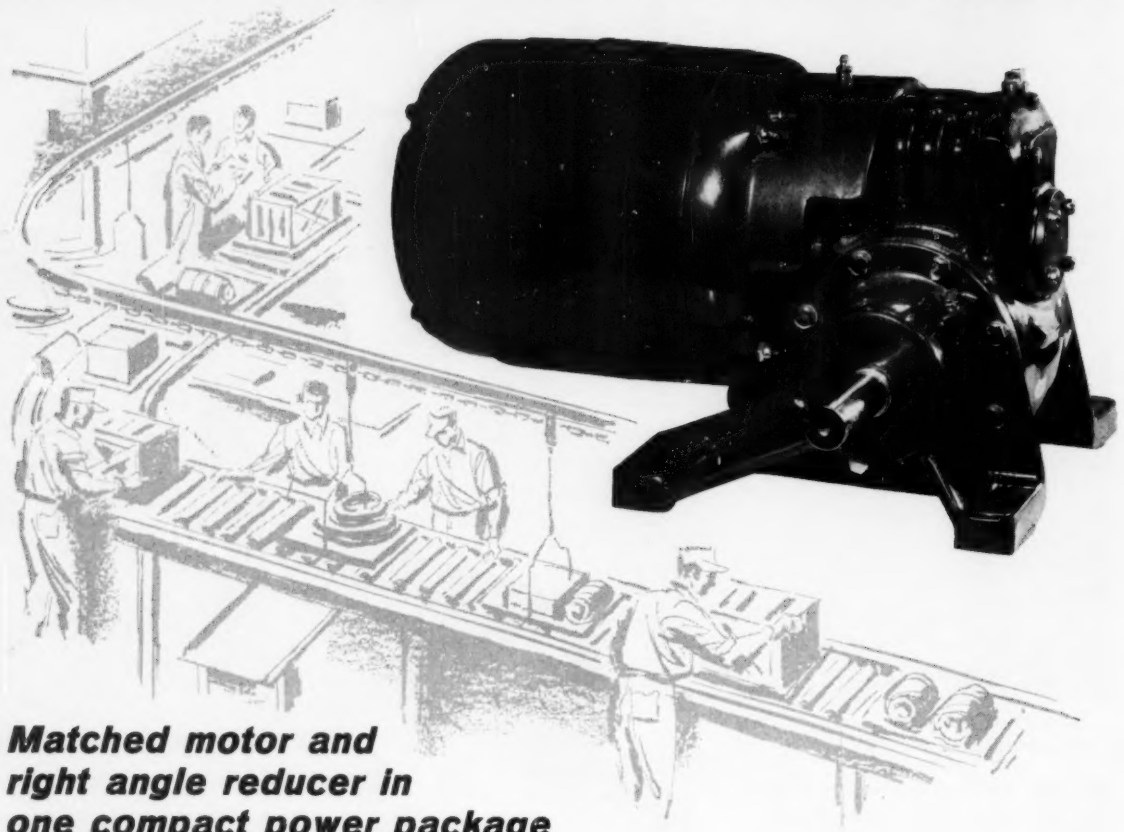
Wooster Pike and Mariemont Ave. Cincinnati 27, Ohio
Custom Gear Makers Since 1907

GEARS, good gears only

Circle 579 on Page 19

MASTER GEARMOTORS

simplify applications—save space



Matched motor and right angle reducer in one compact power package

Reduction of engineering and assembly cost . . . elimination of separate components . . . are basic in this Master Right Angle Gearmotor. Consider these specific advantages:

1. No high speed coupling.
2. No V-belts or chains and sprockets.
3. Takes up less space—reduces mounting plates.
4. Special flange or face mounting can eliminate low speed coupling.
5. Saves aisle space . . . drives around the corner.
6. Wide acceptance by machine builder and user.

Master Gearmotors are built with ratings from ⅛ to 125 h.p. . . . in right angle, parallel or in combination. Right angle ratios are available to 96:1; parallel 120:1.

Electrical and mechanical modifications give you a maximum choice—vertical, horizontal, and flange mountings; output shaft over, under, left or right. These gearmotors can be supplied with built-in accessories: a fluid coupling for hard-to-start loads or cycling loads; a brake for fast stops and positive holding.

Call your nearest Reliance Sales Engineer. Let him tell you why more Master Gearmotors are in use today than any other make. E-1642

Product of the combined resources of Reliance Electric and Engineering Company and its Master and Reeves Divisions

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 2812A, CLEVELAND 17, OHIO
Canadian Division: Toronto, Ontario
Sales Offices and Distributors in Principal Cities

Duty Master A-c. Motors, Master Gearmotors, Reeves Drives, V★S Drives, Super 'T' D-c. Motors, Generators, Controls and Engineered Drive Systems.

Both actuator types are field-adjustable horizontally and vertically. **Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.** K

Circle 801 on Page 19

Stepping Motor

develops extremely high torque

Syncramental stepping motor, only 1½ in. long, develops at least three times greater torque than comparable devices. It is used to rotate potentiometers, counters, rotary switches, tape advances, and various

control mechanisms. Special clutch mechanism replaces use of ratchets, permitting translation of pulses to incremental shaft positions with high accuracy and dependability. Low-cost, long-life unit meets severe environmental conditions. It is available in unidirectional and bidirectional models, ranging in weight from 4 to 13 oz, with angular increments of 36 deg per pulse, up to 15 steps per sec, and load capacity to 2 lb-in. starting torque. Motor brakes at end of each step, for positive locking of load. **G. H. Leland Inc.**, 123 Webster St., Dayton 2, Ohio. G

Circle 802 on Page 19

Rotary Switch

handles complex circuit arrangements

Type MA-12-S solenoid-operated switch provides for remote control of multiple circuits with a compact rotary-switch mechanism. Up to five poles, in a tap switch arrangement having twelve taps per pole, can be supplied. Solenoid coil is available for dc voltages from 6 to 230 v. Self-interrupting contacts, as well as suitable rectifiers for ac operation, are also available. Solenoid requirements in terms of avail-

Circle 581 on Page 19→

NOW! *Adjustable Diameter and Open* THOMSON

BALL BUSHINGS

Adjustable Diameter BALL BUSHING for Zero Clearance

The BALL Bearing for *all* your LINEAR MOTIONS

Precision Series "A" and Low Cost Series "B" BALL BUSHING

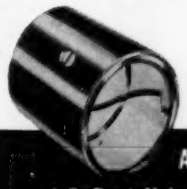
Open BALL BUSHING for Zero Clearance on Supported Shafts

Sliding linear motions are nearly always troublesome. Thousands of progressive engineers and designers have solved this problem by application of BALL BUSHINGS on *guide rods, reciprocating shafts, push-pull actions,* or for support of *any mechanism that is moved or shifted in a straight line.*

Improve your product! Up-date your design and performance with Thomson BALL BUSHINGS!

LOW FRICTION · ZERO SHAKE OR PLAY
ELIMINATE BINDING AND CHATTER
SOLVE SLIDING LUBRICATION PROBLEMS
LONG LIFE · LASTING ALIGNMENT

The various types cover a shaft diameter range of ⅛" to 4". Small sizes available in Stainless Steel. Write for literature and name of our representative in your city.



THOMSON INDUSTRIES, Inc.
Dept. E, MANHASSET, NEW YORK

Also Manufacturers of NYLINED Bearings . . . Sleeve Bearings of DuPont Nylon, and 60 CASE . . . Hardened and Ground Steel Shafting

WHAT'S YOUR
CLAMPING PROBLEM?

Wittek has the answer—Here are a few from among the many different types and sizes of clamps designed and manufactured by WITTEK. Whatever the clamping problem on hose, plastic pipe, duct or other connections, it's a safe bet that WITTEK has the exact type and size clamp to do the job right! Let WITTEK help solve your clamping problems. Write today.

Quality Clamps for Over a Quarter Century

WITTEK Manufacturing Co.
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CLAMPS for Every Application

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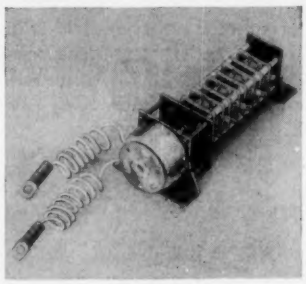


able power supply, pulsing method, frequency of operation, number of operations, and ratio of energized to de-energized time are arranged to customer specifications. Basic switch meets MIL-S-3786. **Electro Switch Corp.**, 167 King Ave., Weymouth 88, Mass. B

Circle 803 on Page 19

Rectangular Steel Tubing

in 2 x 3 up to 2 x 7-in. sizes

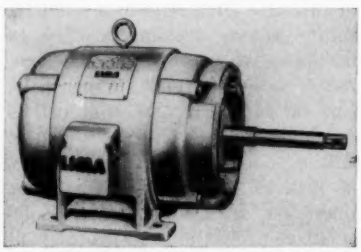
Cold rolled from coiled stock, rectangular steel tubing (butted) is available in sizes 2 x 3 to 2 x 7 in. Sizes 2 x 3 through 2 x 5 in. are offered in 12 gage in standard lengths of 24 and 30 ft. Tubing 2 x 5½ through 2 x 7 in. is available in 11 gage, and in 30 and 35-ft lengths. **Bock Industries, Div., Elkhart Welding & Boiler Works Inc.**, Nappanee Street & Hively Avenue, Elkhart, Ind. J

Circle 804 on Page 19

Pump Motors

have NEMA rerated frame sizes

Dripproof, close-coupled pump motors are available in NEMA rerated frame sizes, from ½ hp at 900 rpm through 75 hp at 1800 rpm, frames through 405 U. Explosionproof and totally enclosed, fan-cooled units are available from ½ hp, 900 rpm through 30 hp. Frame



DYNAMIC DIFFERENCE

in hydraulic performance

Webster

POSITIVE DISPLACEMENT GEAR-TYPE PUMPS

Things have changed on the golf course . . . the old converted Model A has been replaced by more efficient, specialty equipment. Like this Worthington mowing rig. It has front wheel drive, rear wheel steering and gang mowers that raise and lower hydraulically.

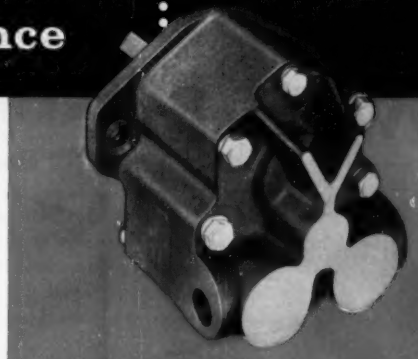
A fast-acting Webster hydraulic pump supplies a dependable flow of fluid power for this versatile application. For this same reason, Websters are used on all types of construction, maintenance, agricultural and industrial equipment. More, Webster Gear-Type Pumps are compact — adapt easily and economically to the job and your product.

Hydraulics in your design? Keep Webster in mind *for the dynamic difference that pays!*

OIL HYDRAULICS DIVISION

WEBSTER ELECTRIC

our 50th year RACINE · WIS



HCS SERIES POSITIVE DISPLACEMENT GEAR-TYPE PUMP

Shaft seal: lip type
Drive: direct, gear or belt
Capacity: 5 sizes, 5 - 17 gpm
Pressure: to 1500 psi
Operating speeds: to 2400 rpm (1800 rpm max. on 4XCS)
Porting: side (Std.) end (Opt.)
Valve: optional; internal relief, adjustable 800 - 1500 psi

BULLETIN HY1 gives complete engineering characteristics — performance and installation data.

Call the man from Webster

. . . he's one of a staff of engineers specially trained in hydraulic application. He can help you solve special problems when hydraulics become a part of your design.

Photo from Worthington Mower Company, Stroudsburg, Pa., a subsidiary of Jacobsen Manufacturing Co., Racine, Wis.

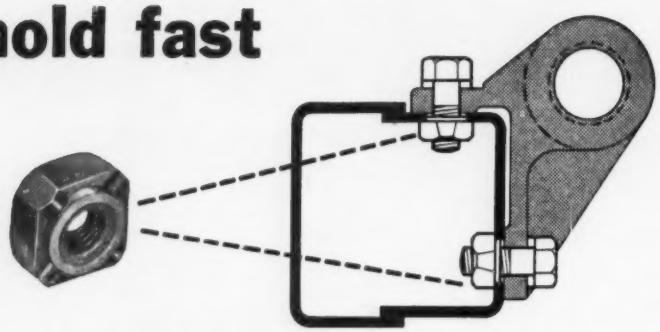
Franklin adv. H-11B

Circle 583 on Page 19

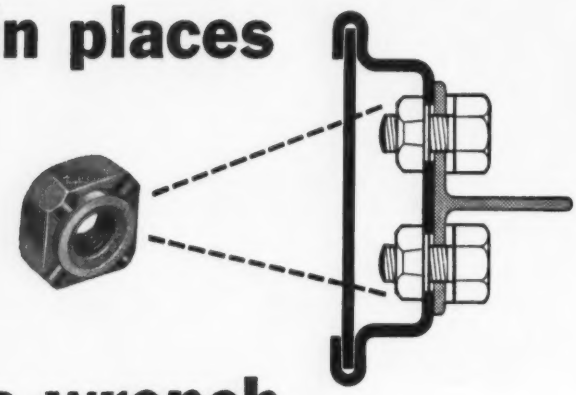
MIDLAND

WELDING NUTS

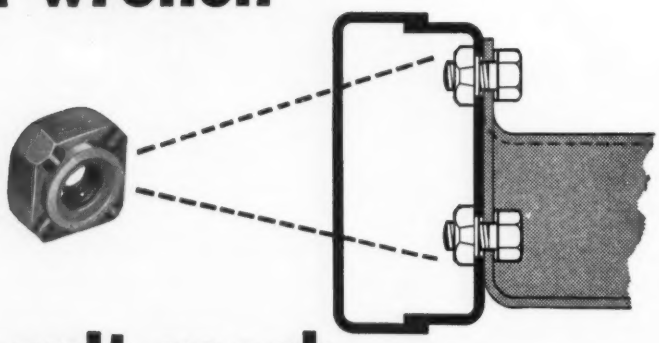
hold fast



in places



a wrench



can't reach

Looking for cost and time-saving tips? Send for the free booklet showing you how to "Save With Midland Welding Nuts."

MR **MIDLAND-ROSS CORPORATION**

OWOSSO DIVISION • OWOSSO, MICHIGAN

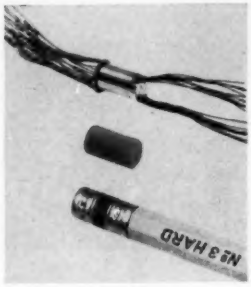
MIDLAND WELD NUT

sizes are 182 through 326 U. Frames are rigid, seasoned, cast iron with integrally cast feet. Die-cast aluminum rotors are equipped with dual cooling fans and entire rotor assembly is dynamically balanced. Prelubricated, sealed ball bearings require no cleaning. Stator windings are impregnated with moisture-resisting, thermosetting, insulating varnish. Uniformity of air gap between rotor and stator is accurately maintained for peak performance. Pump motors can be furnished in either three or two phase, and in all frequencies and commercial voltages below 600 v. **Lima Electric Motor Co. Inc.**, Dept. 139, Lima, Ohio. G

Circle 805 on Page 19

Slip-Ring Assembly

miniature unit is for temperatures of −65 to +350 F



Microminiature slip-ring assembly, including 21 rings, 42 brushes, and two bearings, is smaller than an ordinary pencil eraser. Rating on 6 rings is 2 amp; on 15 rings, 1 amp. It has over-all length of 0.5 in. and diameter of 0.25 in. Temperature range is −65 to +350 F. Leads are Teflon insulated, and case is stainless steel. Rotor is integrally molded, with bearings mounted at both ends. Assembly complies fully with all requirements of MIL-E-5400C. **Slip Ring Co. of America**, 3612 W. Jefferson Blvd., Los Angeles 16, Calif. L

Circle 806 on Page 19

Miniature Resistor

has maximum resistance of 1 megohm

New winding techniques and resistance wire having a diameter of 0.0005 in. make possible Type 1274 resistor with maximum resistance

Circle 584 on Page 19

Circle 585 on Page 19→

Designed to give you *Double Protection!*

WAGNER TYPE DP MOTORS

PROTECTED against corrosion...

PROTECTED against splashing liquids...

WM59-9

Wagner Type DP Motors provide *double protection* that means longer life—more versatility of application. Rugged cast iron frames and endplates are highly resistant to corrosion. Dripproof enclosures are so well designed that these motors can handle many applications that formerly required splashproof motors. These motors pack ample power into little space, are light in weight and are easy to maintain.

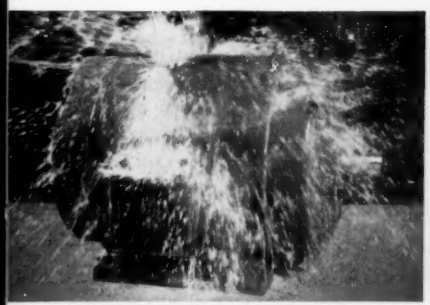
SLEEVE BEARING MODELS AVAILABLE. The entire line of ratings is available with ball bearing construction, or with steel-backed, babbitt-lined sleeve bearings of high load carrying capacity that provide quieter operation.

Let a Wagner Sales Engineer show you how these motors can be applied to your needs. Call the nearest branch office or write for Wagner Bulletin MU-223.

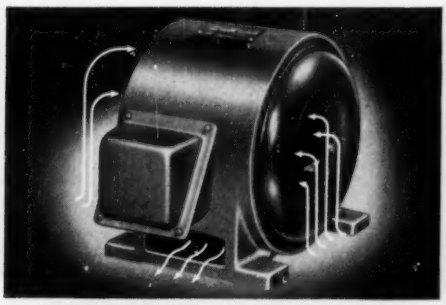
Branches and Distributors in All Principal Cities

Wagner Electric Corporation

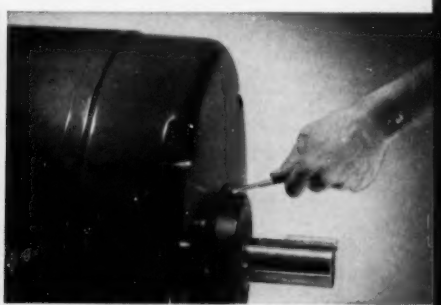
6404 Plymouth Ave. • St. Louis 14, Missouri



DOUBLY PROTECTED—Air intakes and outlets are positioned to provide complete protection against dripping or splashing liquids. Rugged cast iron frames protect against rough handling and corrosion.

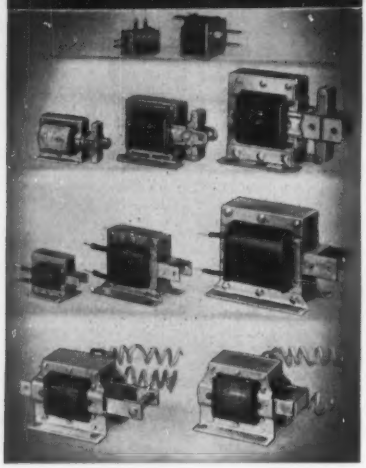


COOLING RUNNING—Specially designed baffles, which protect the stator windings, direct a cooling stream of air through the motor to effectively cool the motor—add to motor life.



CAN BE RE-LUBRICATED—Original factory lubrication will last for years in normal service—but grease plugs are provided to permit re-lubrication that adds years to motor life under severe conditions.

CUSTOM QUALITY STOCK SOLENOIDS FOR EVERY APPLICATION...



available for immediate delivery...

The line consists of 17 models to provide 34 widely differing specifications . . . delivery can be made within 24 hours of receipt of order . . . specifications include: pull and/or push capacities up to 45 lbs., . . . sizes from ¾"x 1⅛" to 3"x 3"... stroke lengths fractional to 2".

All solenoids are built to rigid standards of highest custom quality. Double shading coils provide high sealed pull without excessive AC hum. Electrical characteristics are thoroughly uniform. Units are compactly engineered to extremely close tolerances. Rugged construction provides long service-life under the most strenuous conditions.

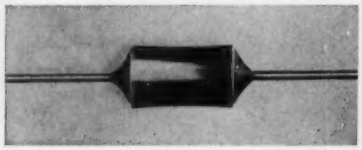
All solenoids in the line can be supplied in any quantity from single units to long-run cost-saving production orders.

Request complete information. Ask for catalog.

DORMEYER INDUSTRIES

3434 N. Milwaukee Avenue, Chicago 41, Illinois

Circle 586 on Page 19



of 1 megohm. Density of resistance by cubic inch is twice as high as on miniature units now in use in miniaturization programs. Dimensions are 3/16 in. diam by ⅜ in. long, with maximum wattage rating of 0.25 w. Resistance tolerances to 0.01 per cent can be obtained. Unit meets all characteristics of MIL-R-93B, Amendment 3, except physical size. Daven Co., Livingston, N. J. D

Circle 807 on Page 19

Asbestos Sheet Packing

for use as gasketing material

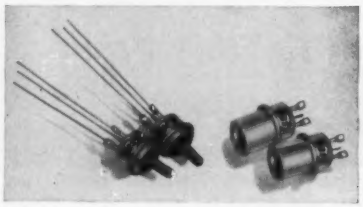
Compressed asbestos sheet packing is available in commercial, intermediate, Navy, premium, neoprene, premium neoprene, and blue asbestos basic grades in standard sheet sizes. It is designed primarily as gasketing material for a variety of industrial uses. All grades except blue asbestos are available in thicknesses of ⅛, 1/16, 1/32, and 1/64 in. Blue asbestos sheets are furnished in ⅛, 1/16, and 1/32-in. thicknesses. **Fibrous Products Div., Union Asbestos & Rubber Co.**, 1111 W. Perry St., Bloomington, Ill. I

Circle 808 on Page 19

Power Transistors

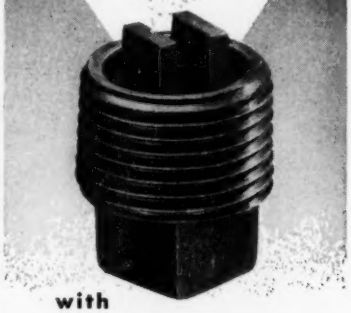
are available in industrial packages

In complementary amplifier circuits, eight pairs of NPN-PNP industrial transistors offer economy, miniaturization, and improved frequency response. Negative feedback can be more easily applied. Transistors are mounted in TO-10 male and TO-13 female packages and are supplied



STOP ABRASIVE WEAR

TO GEARS—BEARINGS AND OTHER MOVING PARTS



with

LISLE *Magnetic* PLUGS

If your product has moving parts operating in a fluid, you can reduce costly abrasive wear with Lisle Magnetic Plugs.

Iron and steel particles that fracture moving parts and circulate in the oil are a primary cause of wear to gears, bearings, bushings, valves, etc.

The Lisle Magnetic Plug attracts these particles, removes them from the lubricant and cuts down wear. Simply use low cost Lisle Magnetic Plugs in place of ordinary drain or fill plugs.

Write for catalog and application data

LISLE CORPORATION
Clarinda, Iowa

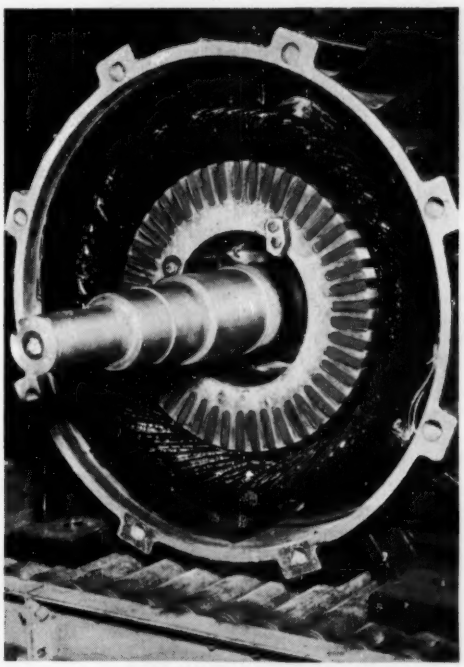
Circle 587 on Page 19

Copper Alloy Bulletin

BRIDGEPORT BRASS COMPANY

Bridgeport "CONTACT BRONZE"
Cuts Costs of Electrical Spring Contacts by 25%

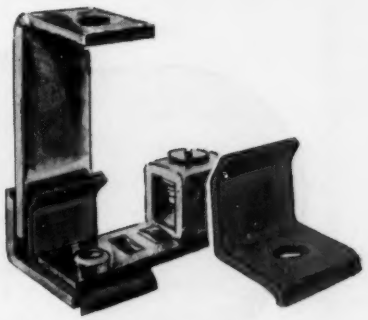
This outstanding Bridgeport alloy offers many of the superior mechanical qualities of phosphor bronze at considerably less cost... with a superior electrical conductivity rated at 22% IACS at 68° soft. Designed to meet the exacting standards of the electronics industry, Bridgeport "Contact Bronze" (Alloy 92) maintains spring properties even after difficult forming operations. Add corrosion resistance and "Contact Bronze" is a guarantee of efficient and reliable performance throughout your product's service life. Here are a few examples:



ELECTRIC MOTORS

The 100-hp 4-pole motors driving extruder-type machines in a dog-food plant were causing frequent production breakdowns. The material processed was so highly viscous that the motors were stalling, jogging and burning out. To meet the high torque, high slip necessary to minimize stalls and also to provide the high thermal capacity required, Allis-Chalmers Company designed a special motor rotor utilizing Bridgeport "Contact Bronze" in place of copper. Burnouts from overload were eliminated and the performance of the "Contact Bronze" motor was so excellent that Allis-Chalmers received an order for another sixteen of the same type.

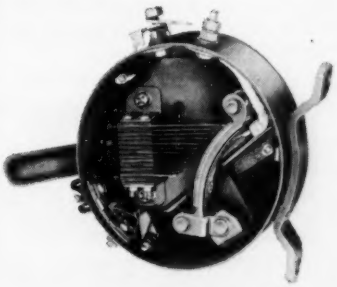
PRESSURE CLIPS



American Electric Switch Division, Clark Controller Company, found that "Contact Bronze" fitted their needs for a lower cost alloy for pressure clips. Its electrical conductivity, corrosion resistance, spring and formability properties were more than comparable with other alloys... at 25% less cost.

TRAILER TRUCK BRAKING SYSTEM

Warner Electric Brake & Clutch Company manufactures an ingenious electric brake system for heavy-duty trailer trucks. Through a graduated series of Bridgeport "Contact Bronze" leaves, it allows the driver to adjust torque instantly and smoothly to suit load and road conditions. The conductivity and performance-proved spring properties of "Contact Bronze" provide added safety and long-haul reliability.



✓Check the Savings
INVESTIGATE "CONTACT BRONZE"

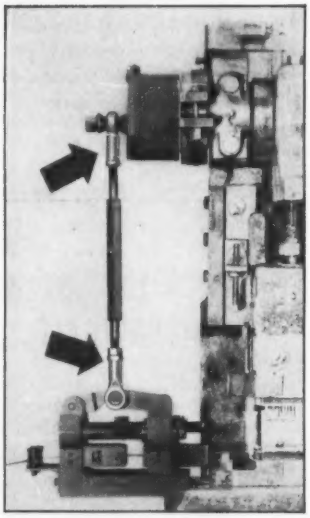
Electronic and mechanical devices, switch gears, circuit breakers, contacts, terminals are just a few of the applications. There are thousands of others. Call your nearest Bridgeport Sales Office or write Dept. 4309 for full details of Bridgeport Contact Bronze. Bridgeport Brass Company, Bridgeport 2, Conn.

Circle 588 on Page 19

How to Make a Linkage

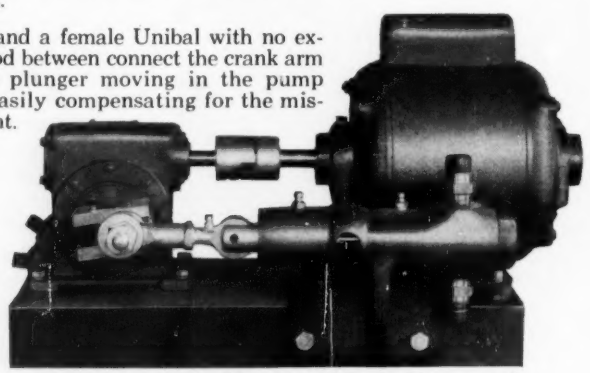
the easy way!

Quick and simple, yet highly effective linkage assemblies are possible with one female threaded and one male threaded Unibal rod end. There is practically no limit to the length of linkages possible.



The misaligned distance between centers is quickly and infinitely adjustable using right and left hand threaded Unibals and an appropriately threaded shaft, using jam nuts to secure the adjustment.

A male and a female Unibal with no extender rod between connect the crank arm and the plunger moving in the pump frame, easily compensating for the misalignment.



There are many ways to use Heim Unibal Rod Ends. If you need engineering or design help, it is available through our engineering department.

Write for list of distributors and the complete catalog . . .

THE HEIM COMPANY

FAIRFIELD, CONNECTICUT

HEIM BEARINGS ARE SOLD BY THE MOST RESPONSIBLE BEARING DISTRIBUTORS IN THE U.S. AND CANADA

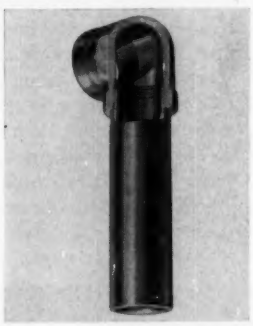
with solder lugs or flying leads. They feature voltages to 100 v and quality exceeding MIL-T-19500A for audio, control, voltage regulation, servo, and computer applications. All types have maximum collector current of 3 amp and minimum large-signal current gain of 30 for a collector current of 0.5 amp. **CBS Electronics, Div., Columbia Broadcasting System Inc.,** 100 Endicott St., Danvers, Mass. B

Circle 809 on Page 19

Pipe Fittings

for hydraulic fluids, water, and air

New 3000-psi forged-steel pipe fittings, precision machined from AISI 12L14 material to meet GMC dimensional standards, are ball drilled to eliminate turbulence and insure smooth flow of fluids. All threads are American Standard Dryseal (NPTF). Recommended proof test



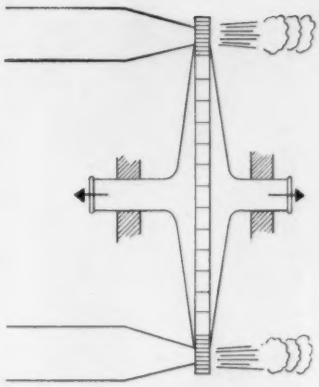
pressures are 15,000 psi for sizes to 1 in. and 10,000 psi for sizes over 1 in. Fittings are for use with hydraulic fluids, water, and air. **Fort Wayne Div., Weatherhead Co.,** 128 W. Washington Blvd., Ft. Wayne, Ind. J

Circle 810 on Page 19

Carbon Potentiometer

miniature unit has humidityproof construction

Model 235 miniature Trimpot features high resistance values, infinite resolution, and humidityproof construction. High-temperature carbon deposited on an inert and moistureproof ceramic base provides excellent temperature and moisture stability, shock, vibration, and acceleration characteristics. Unit measures approximately 5/16 x ¼ x 1¼



ROPER
ROTARY PUMPS

CUSTOM FLOW DIVIDER SOLVES FUEL METERING PROBLEM FOR TURBINE BUILDER

This multiple unit is a series of custom Roper pumping elements driven in tandem by a hydraulic motor. It accurately meters distillate or residual fuel oils to the combustion chambers in a large gas turbine. These rugged units, used on both mobile and stationary turbines, withstand extreme temperature changes during operation. This unusual application is another example of Roper's ability to tackle — and solve — difficult pumping problems.

If you have an application where a standard pump does not fit your needs, Roper can custom-design and build pumps that meet your requirements. For further information, call the factory or the Roper representative in your area.

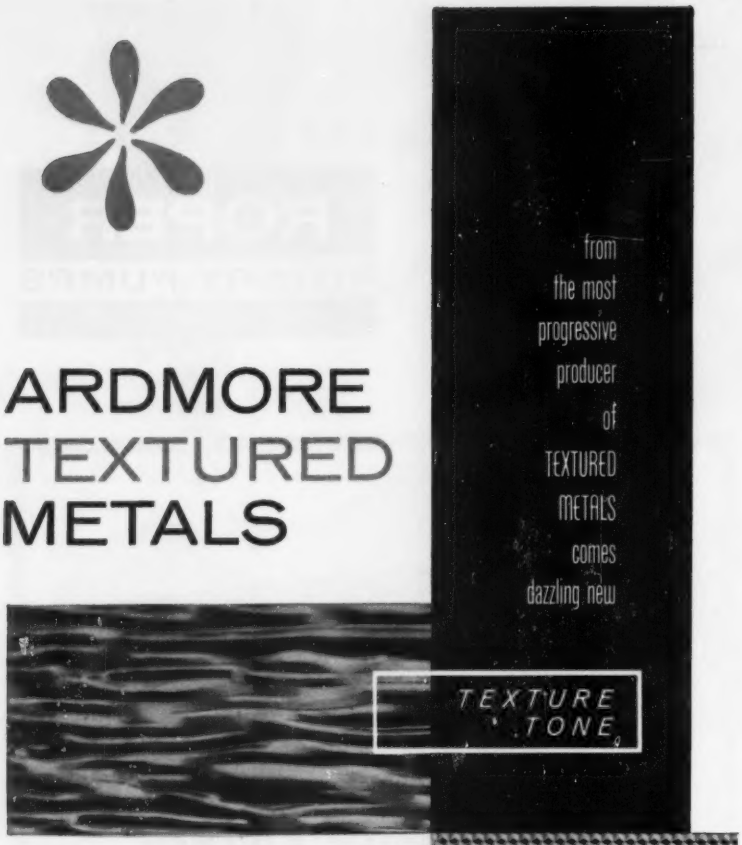
ROPER PRINCIPLE OF ONLY TWO MOVING PARTS ASSURES EFFICIENCY . . . DEPENDABILITY

Roper Pumps are the rotary gear type — two equal size pumping gears operating in a case with proper clearance. This factor promotes long service life and optimum performance on all applications.

ROPER
ROTARY PUMPS

ROPER HYDRAULICS, INC.
Dept. 252 P. O. Box 269
Commerce, Georgia

Circle 590 on Page 19



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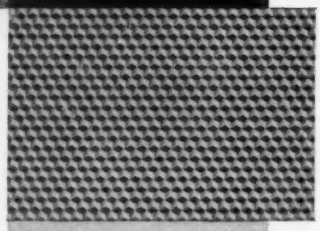
TEXTURED
METALS

* You'll note your product takes on a distinguishing aire of quality, an uncommon "feel" of value, and excites a sudden spurt in sales—when you incorporate Texture-Tone in your product design. This adaptable new finish, applied to lustrous tin-coated steel, can be formulated to comply with your requirements (i.e. elasticity, resistance to abrasion and humidity, etc.). Although it is extremely durable and distinctive in appearance, Texture-Tone is surprisingly inexpensive...as low as 12c per square foot in quantity. Choose from a galaxy of colors and textures.

Ardmore Textured Metals are available in all metals, solid or perforated. Eight new exciting textures in sheets up to 52" in width or continuous coils to 48" width. Multiples, blanks or finished parts are furnished to your specifications.



upper left
Bristol Texture

lower right
Dunhill Texture

Texture Tone finish is available in many colors including Silver, Gold, Copper, (shown above) Green, Red and Blue.

Send today for this new 6 page brochure which describes in detail all of the textures and finishes available (including Texture Tone) together with photos of production applications in all industries.

ARDMORE
PRODUCTS, INC.

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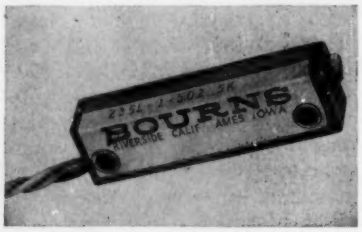
Circle 591 on Page 19



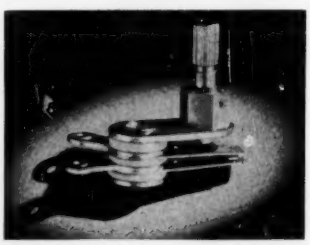
in. and weighs only 0.3 oz. It has a power rating of 0.25 w and operating temperature range from −85 to +257 F. Three terminal types are available—stranded insulated leads, solder lugs, and printed-circuit pins. **Bourns Inc.**, P. O. Box 2112, Riverside, Calif. L

Circle 811 on Page 19

Simple Thermostat

in adjustable or nonadjustable styles

Inexpensive Type B thermostat, simply designed to achieve space economy, is for use on appliances and other apparatus as an overheat control, timing, and controlling device. Unit operates on the principle of current flowing through the bimetal, generating heat. Heat alone, or temperature of ambient air, or both, actuate bimetal to break circuit. As device cools, bimetal returns to normal position, reclosing contacts. Unit is available in



either adjustable or nonadjustable styles. Blade and bimetal can be specified to give any desired performance. Thermostat is normally rated at 5½ amp on 110-120 v ac. **Norwalk Thermostat Co.**, 52 Woodlawn Ave., Norwalk, Ohio. G

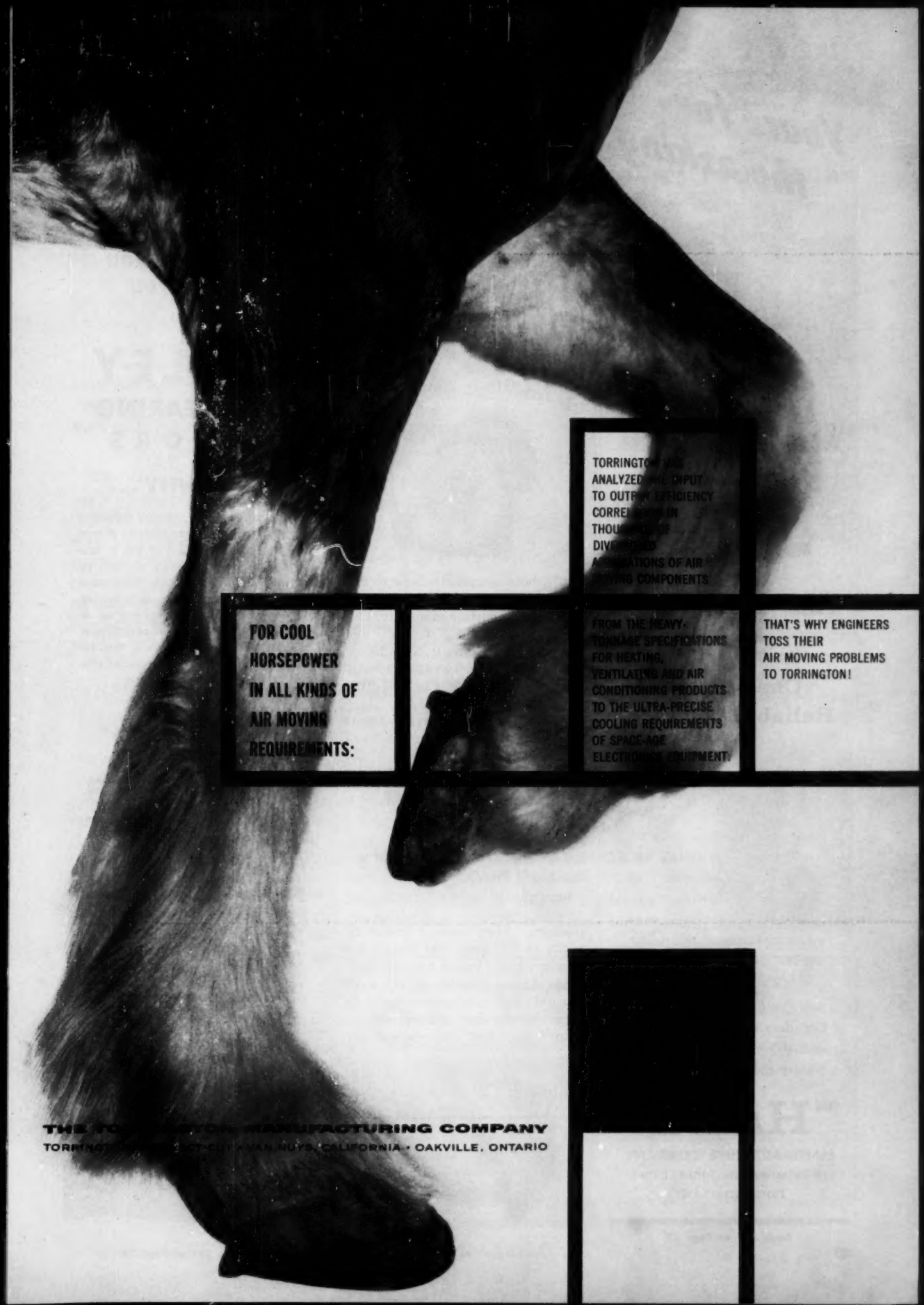
Circle 812 on Page 19

Transistor Timer

has repeat accuracy better than 1 per cent

Series 308 transistorized timer for industrial machine and process au-

Circle 592 on Page 19→


TORRINGTO
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FROM THE HEAVY-
TONNAGE SPECIFICATIONS
FOR HEATING,
VENTILATING AND AIR
CONDITIONING PRODUCTS
TO THE ULTRA-PRECISE
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FOR COOL
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AIR MOVING
REQUIREMENTS:
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AIR MOVING PROBLEMS
TO TORRINGTON!
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This "Diamond H"

Checklist of Reliable Controls

. . . Relays, Thermostats, Switches . . . engineered to meet your specific requirements in a wide variety of applications including air conditioning, appliances, aircraft, missiles, machine tools, panel boards, heater and motor control circuits, and many others.

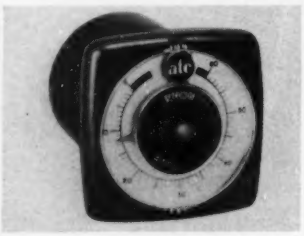
• • •

Ask also for our new application data sheets on Series R and Series W Relays, and Rotary Switches.

THE HART MANUFACTURING COMPANY
118 Bartholomew Ave., Hartford 1, Conn.
Phone JAckson 5-3491

Circle 593 on Page 19

tomatic applications provides extremely high reliability. It has a conservative rating of 3 million operations, and repeat accuracy better than 1 per cent. Filtered power feeds an RC network working through a transistor to operate a relay at end of timing cycle, providing maximum life expectancy and simplicity. No warm-up time is required before energizing timer. Unit features heavy-duty DPDT control contacts rated 15 amp at 115 v ac, 10 amp at 230 v ac, and 4 amp at 115 v dc. Timer mounts into a 3 3/16-in. diam panel cut-



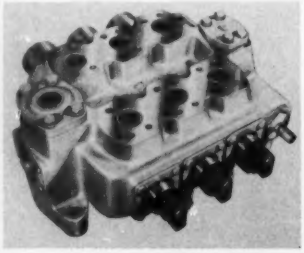
out without special attachments and without screws. Brackets are also available for surface mounting. Dial ranges are 0.02 to 1 sec, 0.05 to 5 sec, 0.125 to 15 sec, 0.25 to 30 sec, 0.5 to 60 sec, and 1 to 120 sec. **Automatic Timing & Controls Inc.**, King of Prussia, Pa. E

Circle 813 on Page 19

Control Valves

have capacity of 150 gpm

Hydraulic control valves for use on construction machinery and other heavy-duty mobile equipment provide finely controlled metering characteristics in raising, positioning, rotating, holding, or lowering operations. They have nominal capacity of 150 gpm, and feature low pressure drop. Valves have an open-center, series-parallel circuit, with integral individual-load check for each cylinder port. They are machined for SAE split-flange port



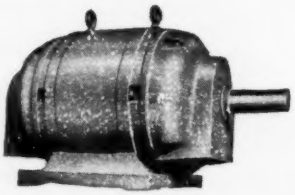
AROUND THE CLOCK PERFORMANCE

that's what you get when you Specify . . .

VALLEY
BALL BEARING MOTORS

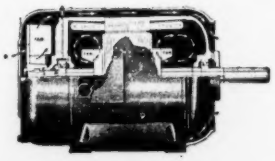
HERE'S WHY . . .

First of all they are specifically engineered to meet the exacting requirements of most power needs — regardless of type or location. Then too, they insure constant, uninterrupted service in high temperatures because they are always cool running. Having enclosed ball bearings you are assured of complete protection against harmful dust and grit. Furthermore, they can handle most power load emergencies without damage to its operating parts.



FAN COOLED

Totally enclosed VALLEY Motor Polyphase, 50 to 60 cycles, constant speed, continuous duty, squirrel cage induction, high torque, low starting current and fully ball bearing, 2 to 60 h.p.



VALLEY
ELECTRIC CORPORATION
4221 FOREST PARK BLVD. - ST. LOUIS 8, MO.

Circle 594 on Page 19

Spaulding FIBRE FACTS FOR ENGINEERS NUMBER 2

THE USES OF VULCANIZED FIBRE'S INHERENT TOUGHNESS

by Earl A. Russell, Chief Engineer, Spaulding Fibre Company, Inc.

The toughness of Vulcanized Fibre often contributes uniquely to meeting crucial requirements of an application as well as to making possible low cost fabrication. For example a vulcanized fibre kickback plate in a bowling alley makes effective use of its built-in toughness while in an automobile starter switch the toughness of fibre permits swaging a supporting bushing to fit the switch case.

What die casting does in reducing the cost of odd shaped parts in metals, swaging does with vulcanized fibre. In addition to being tough enough to readily withstand punching operations, it is also sufficiently plastic to permit swaging to shape. In this particular swaging operation the fibre is compressed in some areas and flowed into raised areas to form a shank fitting into the hole and a shoulder fitting the contour of the starter switch case (Fig. 1).

In the assembly the sturdy switch contacts are economically mounted and fully insulated with vulcanized fibre, taking advantage of the toughness of the fibre parts to provide adequate support against the impact of entering switch contacts.

It may be noted further that combined with the toughness to withstand punching and the plasticity to permit swaging into low cost parts, vulcanized fibre provides the required electrical insulation.

In the bowling alley application (Fig. 2) wood could not take the beating from the pounding blows of the pins as they smash against the partitions that separate the alleys. For protection of the wooden partition, the toughness of vulcanized fibre is required to withstand the repeated blows from the pins. At the same time the fibre must be sufficiently plastic to avoid damaging the pins yet resilient enough to provide acceptable rebound for desirable pin action.

Fibre performs these unusual functions through years of service at surprisingly low cost.

In railroad track insulation, athletic protective parts, gaskets for high pressure systems, switch parts, electric motor parts and formed parts for many applications, the toughness of fibre combines with other important properties to provide a simple part which performs two or more functions with good results and low cost.

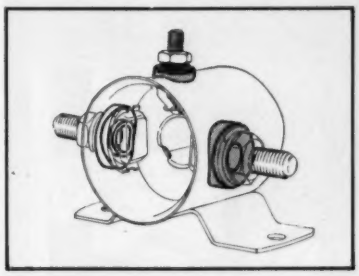


FIGURE 1. A complex shape difficult to machine by ordinary methods, this vulcanized fibre bushing is swaged and punched in one operation to produce a low cost part to meet strict requirements of toughness. Supporting heavy duty contacts under repeated shock loads, the bushing also insulates the contacts against the surrounding case.

FIGURE 2. Tough vulcanized fibre kickback plate absorbs the impact of the flying pin without damage to the pin or the partition. The rebound action, so necessary to top scores, is possible because of the resiliency of the fibre.

FREE

A NEW 12-PAGE REFERENCE BOOK FOR YOUR DESIGN FILE

Devoted exclusively to complete engineering data on Vulcanized Fibre. Send for your copy today.

SPAULDING FIBRE COMPANY, INC.
332 Wheeler Street
Tonawanda, New York

Please bring my engineering file up-to-date by sending a free copy of Spaulding's "Vulcanized Fibre Engineering Data"

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Firm_____

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Circle 595 on Page 19

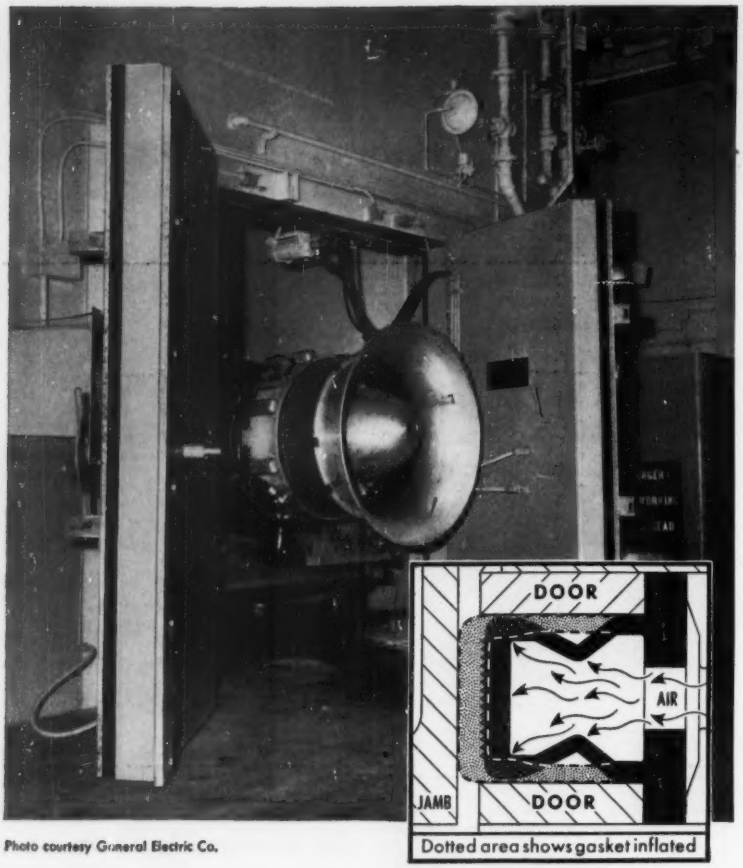

Photo courtesy General Electric Co.

Pneumatic Rubber *Door Seal* Muffles Test Cell Noises

To more effectively suppress noise, General Electric jet engine test cells are equipped with a unique pneumatic rubber door seal. Mounted on door perimeter, this seal is designed to expand proportionally and insure a perfect seal over its entire sealing surface *including the corners*. Not only does this gasket dampen the noise but it permits more accurate testing through quieter working conditions.

Continental engineers developed this pneumatic gasket for this and similar applications. Compounded of special flex-resistant rubber, this versatile gasket can be operated with intermittent flexing cycle *or* as a continuous seal—can be adapted to various other types of doors—for *either* pressure or vacuum rooms.

The design of this gasket typifies the engineering skill offered by Continental. When you need "engineered rubber parts"—molded or extruded—enlist the service of specialists—consult Continental.

Engineering Catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

Another achievement in **RUBBER**
engineered by **CONTINENTAL**

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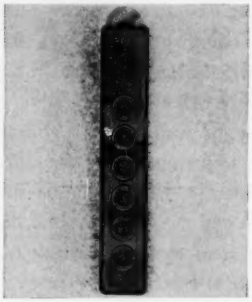
connections. Recommended operating pressure of the two and three-spool versions is up to 2000 psi. **Parker Hydraulics Div., Parker-Hannifin Corp.**, 17325 Euclid Ave., Cleveland 12, Ohio. F

Circle 814 on Page 19

Pendant Switch

is contained within Hycar enclosure

Six-station switch for pendant applications is completely contained within a molded two-piece Hycar enclosure that features waterproof, noncorrosive, lightweight construction. Each button is an integral part of housing and completely en-



closes each of six precision snap-action switches. Water, dust, grime, or weather cannot reach switch to cause breakdown. Ring-shroud protects each button from accidental action from any side direction. **Electrical Products Div., Joy Mfg. Co.**, 1201 Macklind Ave., St. Louis 10, Mo. I

Circle 815 on Page 19

Silicone Varnish

cures at low temperatures

Developing optimum electrical properties at cure temperatures of only 150 C, SR-220 silicone impregnating varnish offers superior heat life and excellent shelf life and tank stability for manufacturers of transformers and electronics equipment. Thermal endurance is superior to conventional silicone impregnating varnishes. Varnish has high initial dielectric strength which remains relatively constant even after extended heat aging. **Silicone Products Dept., General Electric Co.**, Waterford, N. Y. C

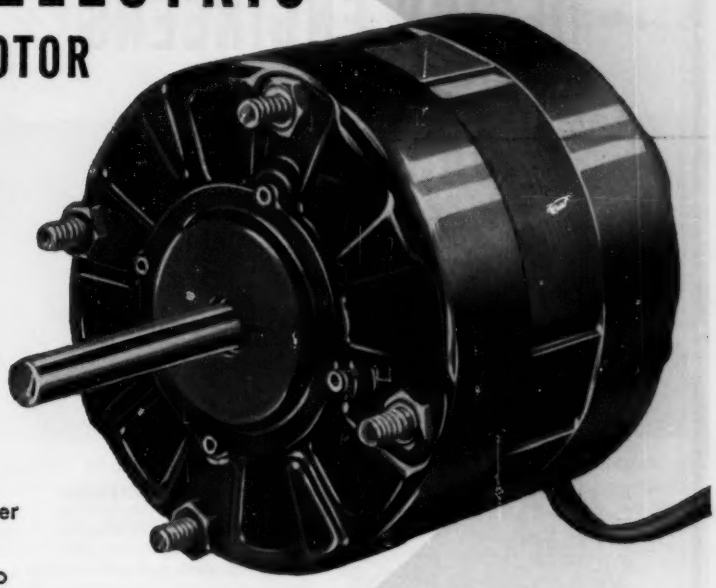
Circle 816 on Page 19

this new TYPE 23

UNIVERSAL ELECTRIC

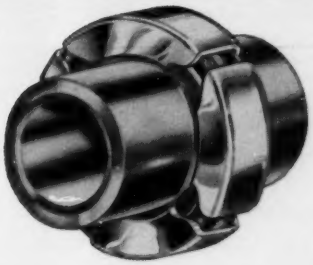
FRACTIONAL HP MOTOR

packs greater power into a smaller motor



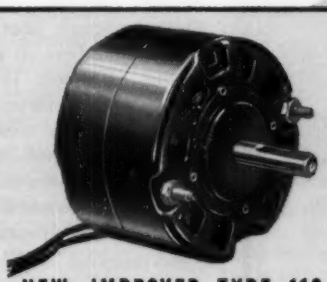
handles jobs formerly requiring larger, more expensive units

UNIVERSAL ELECTRIC announces a new 4-pole, shaded pole fractional HP motor . . . the TYPE 23 . . . which provides greater power than previous motors of larger dimensions. Available in sizes from 1/50 to 1/12 HP. The improvements that have made this motor more efficient are newly designed laminations, improved rotor construction, improved material processing and the new, *free-aligning* **Universal Bearing.**



This revolutionary new free-aligning Universal Bearing* eliminates fractional HP motor problems due to misalignment. It is always in balance and can adjust to shaft misalignment 100% of the time under any load conditions. Provides longer bearing life, better lubrication, easier starting and quieter operation. Now being used in the new TYPE 23 and the redesigned TYPE 118 UNIVERSAL ELECTRIC motors.

*PATENT APPLIED FOR



NEW, IMPROVED TYPE 118 FRACTIONAL HP MOTOR

More rugged and precision built from highest quality materials, the redesigned TYPE 118 motor . . . available in sizes from 1/200 to 1/50 HP . . . is ideal for applications requiring maximum dependability and long life. Depending on power requirements, both the TYPE 118 and TYPE 23 motors are ideal for kitchen ventilators, unit heaters, tape recorders, refrigeration equipment, record players, pump units, etc.

Write for complete information on UNIVERSAL ELECTRIC TYPE 118 and TYPE 23 fractional HP motors and the new free-aligning **Universal Bearing.**

UNIVERSAL ELECTRIC COMPANY

PRECISION ELECTRIC MOTORS

EXECUTIVE AND GENERAL SALES OFFICES: OWOSSO, MICHIGAN, DEPT. 10

Circle 597 on Page 19

Openings for

DESIGN ENGINEERS

for

GAS TURBINE ENGINES

in Solar's rapidly expanding gas turbine programs in sunny San Diego

Solar has immediate openings for Preliminary Design and Product Design Engineers in its fast-moving gas turbine programs. Several new contracts have been received for industrial, non-military applications, as well as certain new military turbine development jobs. This growing diversification has created expanding challenges and opportunities. Solar is a world leader in small gas turbines, having pioneered in their design and development since 1945. The company has built and sold more than 2500 gas turbines. Join in this exciting work now for a brilliant future.

QUALIFICATIONS

B.S. in Engineering preferred, plus at least three years experience in gas turbine design. U.S. citizenship not required for some of the positions open.

SOLAR SPECIFICS

Solar is a medium-sized company (2500 people) that has been in the mechanical and aeronautical engineering fields since 1927. It is big enough to offer the most advanced personnel policies, yet small enough so you don't get lost in the crowd. Salary and performance reviewed semi-annually. Liberal relocation allowances. The special professional status of engineers is appreciated and recognized. A new 60,000 sq. ft. engineering building, necessitated by expanding research and development, will be completed soon on the edge of San Diego Bay.

SEND RESUME

Please send resume of your qualifications to Louis Klein, Dept. **E-446**, Solar Aircraft Company, 2200 Pacific Highway, San Diego 12, California.

SOLAR AIRCRAFT COMPANY

LIVE BETTER, TOO! In addition to greater opportunities for personal achievement, Solar offers you the chance to live better in sunny San Diego. This famous resort area has the finest year-around climate in America. Cultural, recreational and educational facilities are excellent. You and your family will enjoy life more at Solar in San Diego.

ENGINEERING DEPARTMENT

EQUIPMENT

Portable Temperature Chamber

for temperatures from −100 to +500 F

Accurate portable temperature chamber maintains temperatures within ±0.2 F over range of −100 to +500 F. Series 1060 includes a rack-mounted model with test volume of 10 x 7 x 7 in., two bench models with same test volume, and

wide-drawer model with test volume of 16 x 7 x 7 in. Unit operates on 117 v ac and contains a centrifugal blower to assure temperature uniformity throughout test space, which is fully insulated with low-conductivity inorganic fiber. Liquid-CO_2-cooled chambers, in addition to providing extremely fast temperature pull-down, can be programmed with simple auxiliary timer to alternate between high and low temperature. All chambers are constructed with stainless-steel inner liners. **Delta Design Inc.**, 7460 Girard Ave., La Jolla, Calif. L

Circle 817 on Page 19

Pressure Transducers

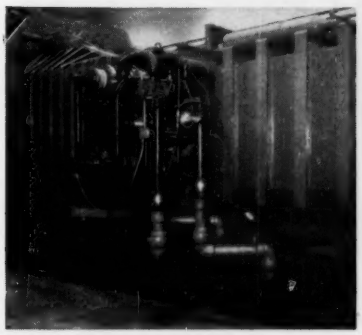
allow easy recalibration

Built to withstand severe environmental conditions, SP2-518 transducers are furnished in pressure ranges from 0-50 through 0-5000 psig. They feature an accessible recalibrating terminal board with bobbin-wound resistors for thermal gain and zero shift compensation, gain adjustment, and input-impedance adjustment. Bridge impedances can be specified from 50 to

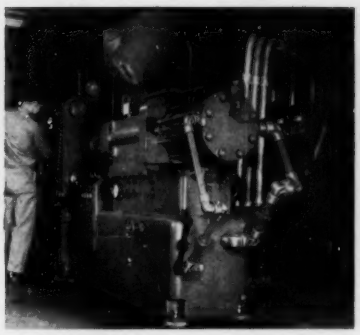
ON EQUIPMENT LINES ■

CHIKSAN SWIVEL JOINTS

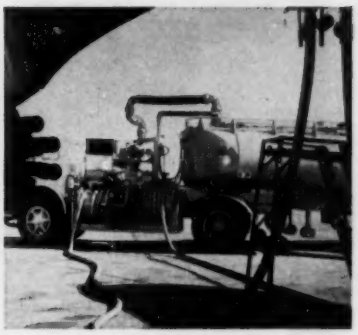
team up strength + flexibility + endurance...



QUICK DISCONNECT FOR A SUPERSONIC WIND TUNNEL—On lines that require frequent disconnecting, such as on this wind tunnel, Chiksan swivel jointed assemblies, teamed with Weco Unions, disconnect quickly, swing out of the way and then back into perfect alignment. **For application details, request report 008.**



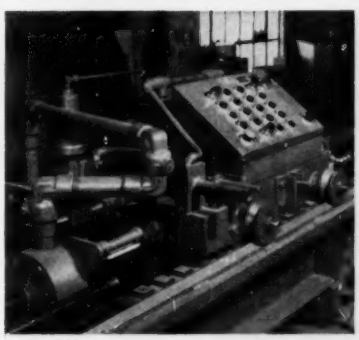
0 TO 2000 PSI IN ONE SECOND—injection molding machine lines must be flexible. Safety is a must. Endurance highly desirable. Chiksan Swivel Joints not only fulfilled these important requirements but their savings in replacement cost soon paid for the swivel joints. **For applicable details request report 001.**



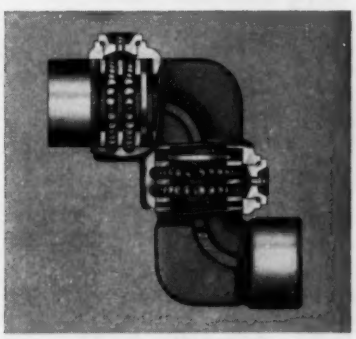
SAFETY LINK FOR JET-FUEL DELIVERIES—In design of trailer tankers for fueling jet aircraft one danger point was the suction line from pump to the trailer. By employing Chiksan Swivel Joints desired flexibility was maintained and the danger of kinking was eliminated. **For application details request report 006.**

When moving machine parts cause tight bend or twist on hose lines, Chiksan Swivel Joints are a ready solution. Or when your design dictates the use of flexible metal lines, Chiksan Swivel Joints allow controlled flexibility. Whenever line endurance, strength and flexibility are desired Chiksan Swivel Joints may offer a ready solution.

Chiksan Swivel Joints with their infinite service life, full 360° rotation and high safety factor, quickly pay for themselves by minimizing hose replacement and by eliminating costly line failure, fluid loss and downtime. For expert advice on your line design problems contact Chiksan. A nearby representative will call, analyze your requirements, and make specific recommendations.



ON THE MOVE 24 HOURS A DAY—Every five seconds right around the clock this machine tests finished pipe with water under pressures up to 1000 psi. Line movement is almost continuous. The solution. For safe, flexible lines of maximum endurance—Chiksan Swivel Joints. **For application details request report 010.**



DESIGN WITH SWIVEL JOINTS—Over 2,000 different types, sizes and styles give you an excellent selection of swivel joints for your design application.

Send for illustrated literature ➡

CHIKSAN COMPANY, 330 North Pomona Ave., Brea, California

☐ Please send me your latest General Catalog
Please send me product application report ☐ .001 ☐ .006 ☐ .008 ☐ .010

Name_____

Company_____ Title_____

Address_____

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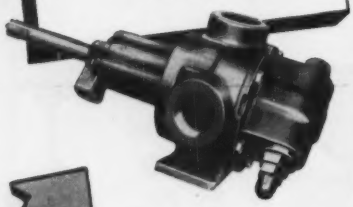

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Put the newly designed Wayne Rotary Pumps on your equipment and boost efficiency and reduce costs. There's a Wayne Rotary Pump for every type of equipment to pump all types of products—from glue to gasoline . . . syrup to toluene.

Wayne's gear-within-a-gear pumps now have improved hydraulic balancing, new seals and mounting arrangements . . . available in sizes from 3 to 500 gallons per minute. Whether you require one pump for your plant, or many for the equipment you manufacture, there is a long-life Wayne design to save you money.

GET NEW DATA

Ask your Wayne representative to recommend the right iron, bronze or special metals construction for your pump application. Send for the new Wayne Rotary Pump Engineering Manual.

THE WAYNE PUMP COMPANY
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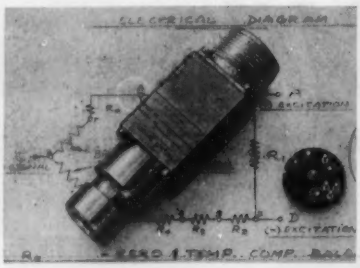
Wayne
PUMPS

Circle 600 on Page 19



2000 ohms. Sensitivity is 3 mv ±0.015 per v with total error of less than 1 per cent of full scale. Nonlinearity and hysteresis errors combined are less than ±0.5 per cent of full scale. Over-all dimensions are 3.26 in. long by 0.98 in. square; fittings are available to reduce length to 2.5 in. **Standard Controls Inc.**, 1130 Poplar Place, Seattle 44, Wash. M

Circle 818 on Page 19

Photopositive Paper

produces sharp, high-contrast prints

Direct photoprint paper is available in extra-thin, 0.003-in. thick, 100 per cent rag-content paper or extra-strong vellum. Both types can be processed in ordinary room light using standard photographic solutions. Both produce clear, sharp, intermediate prints or printing masters. They make wet-erasable prints ready for redrawing with pen or pencil. **Eugene Dietzgen Co.**, 2425 N. Sheffield Ave., Chicago 14, Ill. J

Circle 819 on Page 19

Power Supply

all-solid-state unit has low heat output

Model 738-001 power supply provides an output up to 3 amp at 130 v dc for laboratory and instrumentation use. The all-solid-state unit operates at an efficiency in excess of 80 per cent under full-load conditions where input supply is 125 v ac. It provides regulation to ±2 per cent at primary power inputs of 105 to 125 v ac, 50 to 60 cps. Ripple is less than 1 per cent rms and can be held to ¼ per cent if required. For line or load changes of 1.5 amp, output voltage transient remains within ±3 v of steady value. Reliable op-

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ENGINEERED MECHANICAL SEAL

. . . spells out the answer to your sealing problems

D ecreases maintenance expense
U naffected by corrosives
R otates with the shaft
A djusts itself automatically

S eals abrasive liquids
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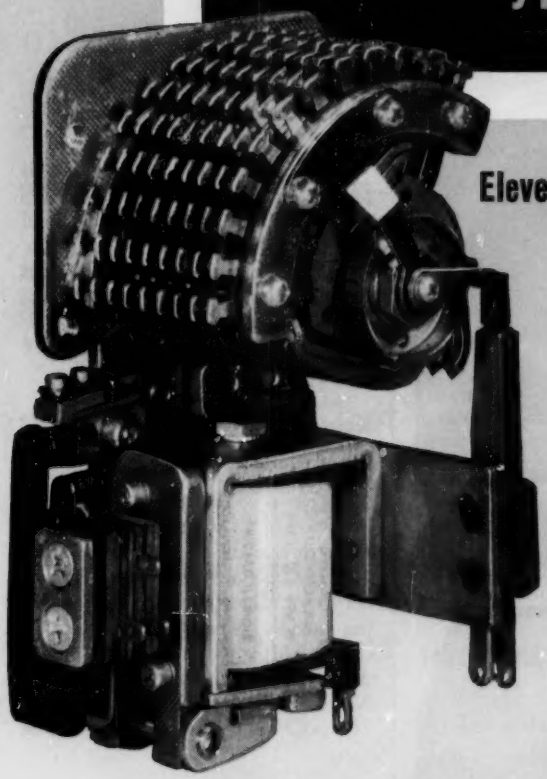
Circle 601 on Page 19

CLARE ANNOUNCES THE
Type 211 Stepping Switch



Eleven-point stepping switch has 12-level capacity, 100,000,000-step* life

Many new, improved features give this Clare Type 211 springdriven stepping switch longer service life, greater capacity and a freedom from maintenance hitherto unknown in an 11-point switch. Rugged, compactly built, the 211 is available with a variety of enclosures and mounting assemblies to meet a wide range of design applications.

LONGER LIFE EXPECTANCY—This new switch has a life expectancy of from 100 million steps at twelve levels to 300 million steps at three levels with proper relubrication and readjustment.

GREATER STEP CAPACITY—Up to twelve 11-point levels or four 33-point levels enable it to handle complex switching, counting, totalizing, selecting, and sequence control operations.

SIMPLIFIED MAINTENANCE—Fewer moving parts, due to the elimination of pawl bearings, and a more rigid armature arm simplify maintenance and increase service life.

TYPE 211 SWITCH—ELECTRICAL DATA

OPERATING SPEEDS—Self-interrupt speed: 60 SPS at 25°C on nominal voltage. Remote impulse speed: 30 SPS at 25°C on nominal voltage with 66⅔ make impulse.

OPERATE & RELEASE TIME—Operate time: 20 ms at 25°C on nominal voltage. Release time: 10 ms at 25°C on nominal voltage.

OPERATE & RELEASE VOLTAGE—Maximum pull-in at 25°C is 66⅔ of nominal voltage. Minimum dropout at 25°C is 5% of nominal voltage.

BREAKDOWN TEST—1000 v, rms, 60 cps, is standard.

COILS—Coil resistances for typical voltages are shown below:

Voltage Vdc	1-8 Levels Ohms	9-12 Levels Ohms
6	1.5	1.5
12	6	6
24	24	20
48	100	70
60	150	100
110	600	400

TYPE 211 SWITCH—MECHANICAL DATA

OVERALL DIMENSIONS—Length (maximum)—4-5/16 in. Height (1C interrupter, 1C O.N.S.)—2¾ in. Width—from 1-5/16 in. for 3 levels to 2-13/16 in. for 12 levels.

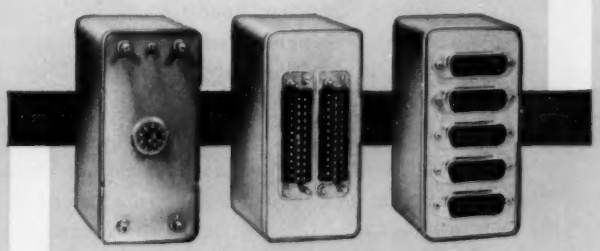
NET WEIGHT—From one pound for 3 levels to 1¼ pounds for 12 levels.

BANK CONTACT—Standard is phosphor bronze. Also available are coin silver or gold plated phosphor bronze.

MAXIMUM BANK LEVELS & PILEUPS

Type of operation (points)	11	33
Bank levels maximum (electrical)	12	4
Interrupter springs	6	6
Off-normal springs	6	6
Number of ratchet teeth	33	33

WIPERS—Standard wipers are non-bridging phosphor bronze with coin silver and gold plated phosphor bronze available in either non-bridging or bridging models.



VARIETY OF ENCLOSURES—Hermetically sealed enclosures, filled with nitrogen or oil, are available with hook-type solder terminals. Dust cover enclosures are available with miniature or standard Amphenol Blue Ribbon connectors.

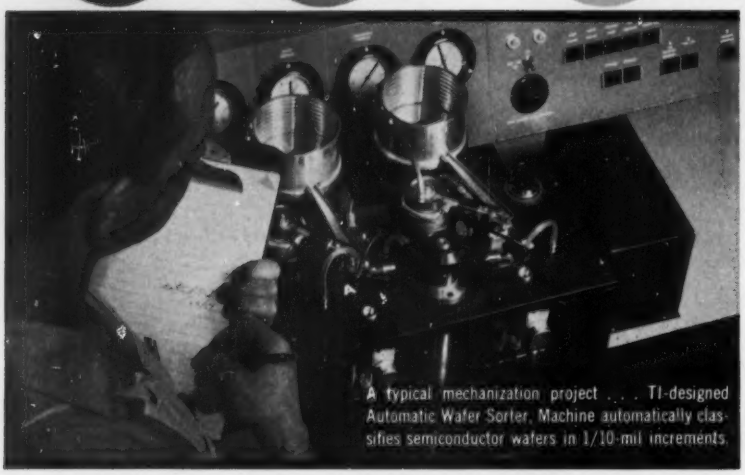
Write for bulletin CPC-3 to C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., P. O. Box 134, Downsview, Ontario. Cable Address: CLARELAY.

CLARE RELAYS

FIRST in the Industrial Field

Circle 602 on Page 19

CAREER OPPORTUNITIES AT TI



A typical mechanization project . . . TI-designed Automatic Wafer Sorter. Machine automatically classifies semiconductor wafers in 1/10-mil increments.

MECHANIZATION ENGINEER

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Accelerate your professional growth by joining one of Texas Instruments most important operations....the mechanization of semiconductor manufacturing equipment!

Work with or lead a mechanization team of top talent with advanced facilities. Specific and rewarding assignments include the design and test of production and prototype equipment on a problem-solving basis, and you will materially contribute to TI's record of engineering and manufacturing achievements.

Advanced personnel policies include company-paid profit sharing (last year 15% of base salary) . . . and premium living is furnished by Dallas' climate and excellent neighborhoods, schools and shopping facilities.

These jobs require a high degree of mechanical aptitude and at least three years' work in design of manufacturing equipment for precision components.

Interviews will be held in your area soon.
Please send a resume immediately to:

For immediate Eastern appointment, contact W. T. Hudson Dept. 203-E-MD 1141 E. Jersey St. Elizabeth, N. J.

C. A. Besio, Dept. 203-MD

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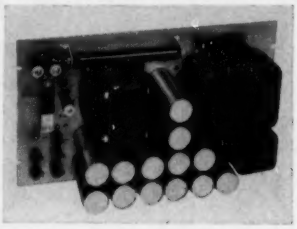


eration at low heat generation is obtained by utilization of transistors and controlled rectifiers. Unit panel is mounted, 16½ in. wide, 7 in. high, 8 15/16 in. deep. **Western Design Div., U. S. Industries Inc.**, Santa Barbara, Calif. F

Circle 820 on Page 19

Nonreflecting Tapes

are available in seven widths

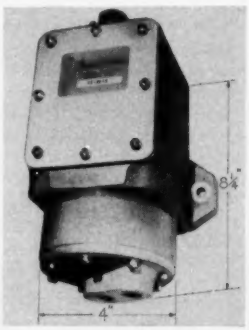
Selection of 15 colored matte-surface tapes are completely nonreflecting and can be written on with pen, pencil, or almost any standard marking device. They are available in seven widths from 1/32 to 1 in. **ACS Tapes Inc.**, 217 California St., Newton 58, Mass. B

Circle 821 on Page 19

Pressure Transducer

performs accurately in low pressures

Compu-tran low-pressure cell performs high-accuracy measurements in low-pressure range. Simple, sturdy electromechanical sensing system eliminates linkages, contacts, and other potential sources of trouble. Sensing element is a precision Ni-Span-C capsule, which, in addition to having excellent hysteresis characteristics, allows close-tolerance performance over wide tem-

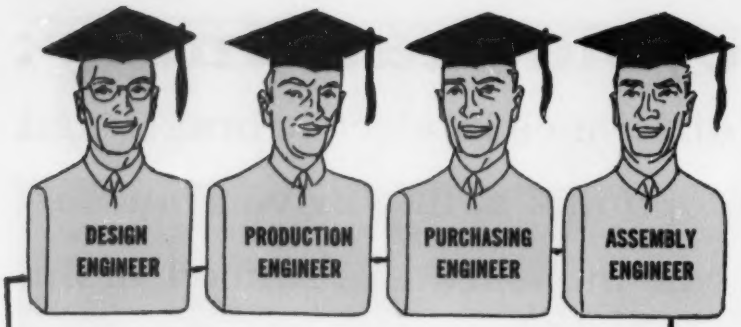


For high-cycle machinery:

There's a big, new difference in electric brakes and clutches—Warner's optional spline drive armature. A difference you can measure in reduced maintenance on high-cycle drives because the precision splined hub distributes the load evenly, with no backlash. A difference in your cost, too, because hub and armature both can be assembled easier, faster, for less money. Write for Bulletin P-68.

NEW
SPLINE DRIVE
ARMATURE

Circle 603 on Page 19



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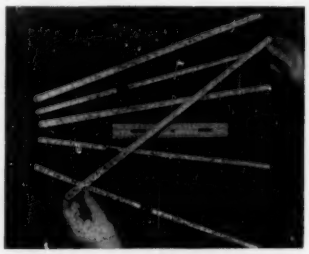
perature range. Expansion or contraction of capsule with changes in pressure results in a small displacement of core of a differential transformer. Magnetomotive nature of transformer provides infinite resolution, and output signal is linear and stepless. Various forms of instrument are available for the measurement of gage, differential, and absolute pressures. Standard ranges available are from 0-1.5 to 0-60 psi, with four intermediate ranges. **International Resistance Co.**, 401 Broad St., Philadelphia 8, Pa. E

Circle 822 on Page 19

Ceramic Tubing

for high-temperature instrument protection

Beryllium-oxide ceramic tubing in lengths to 24 in. is highly resistant to elevated temperatures and thermal shock. Berlox tubing is supplied with both ends open or with one end closed, for insulation and protection of thermocouples and other



sensing and measuring elements for use at extremely high temperatures or where heavy radiation is encountered. Tubing is also used to introduce materials to or draw samples from areas where temperatures are very high or corrosive conditions are extreme. Properties include melting point of 4650 F, excellent strength above 2000 F, high hardness and abrasion resistance, high electrical resistivity combined with high thermal conductivity, and immunity to heavy radiation. Round, single-bore tubing is available from stock in lengths to 21 in. and to 24 in. on special order. Standard sizes are 5 mm ID x 7 mm OD, ¼ x ⅜ in., ⅜ x ½ in., and 7/16 x 11/16 in. **National Beryllia Corp.**, 4501 Dell Ave., North Bergen, N. J. D

Circle 823 on Page 19

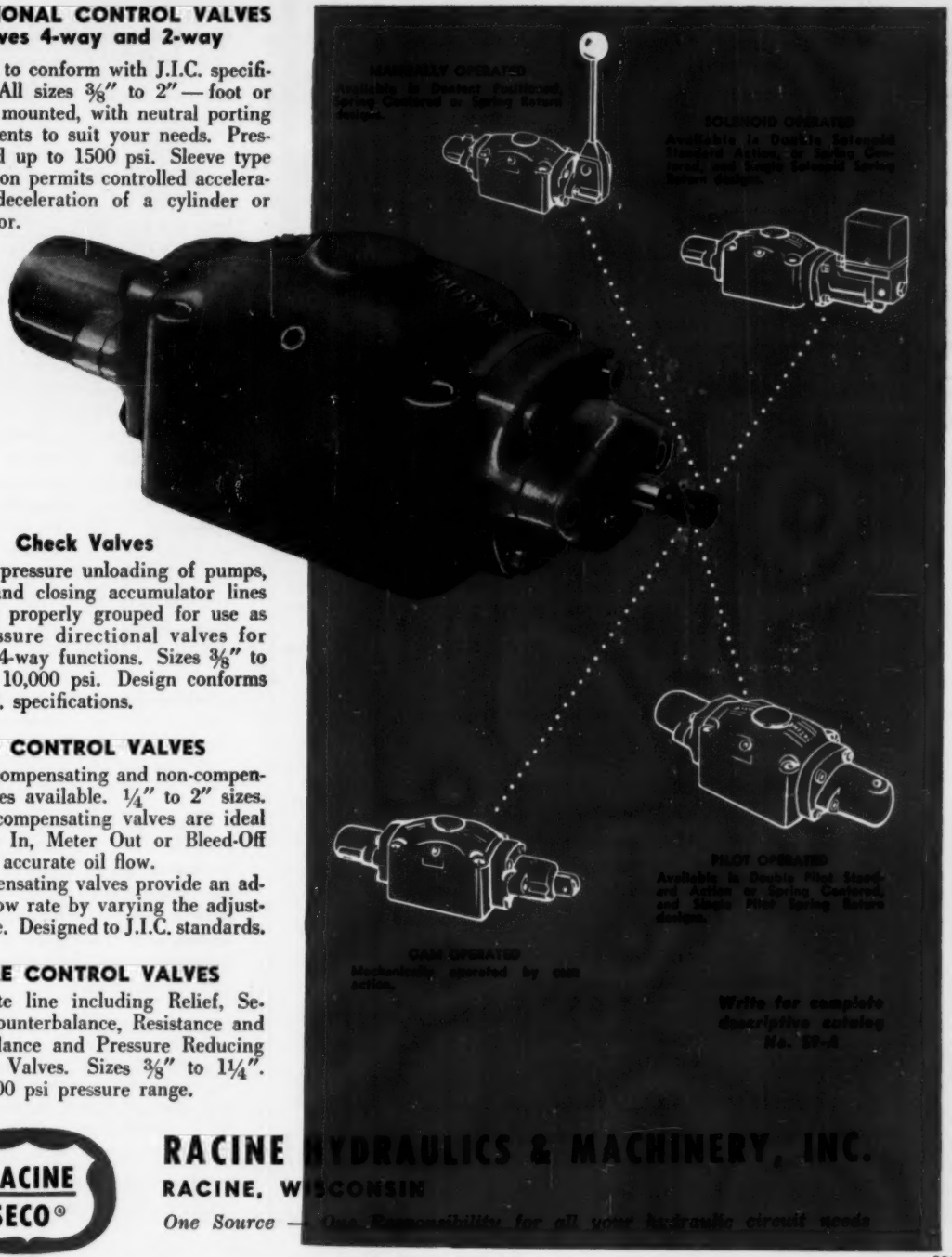
Circle 604 on Page 19

RACINE-SECO®

Hydraulic Valves

DIRECTIONAL CONTROL VALVES
Valves 4-way and 2-way

Designed to conform with J.I.C. specifications. All sizes 3/8" to 2" — foot or sub-plate mounted, with neutral porting arrangements to suit your needs. Pressure rated up to 1500 psi. Sleeve type construction permits controlled acceleration or deceleration of a cylinder or fluid motor.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For high pressure unloading of pumps, opening and closing accumulator lines and when properly grouped for use as high pressure directional valves for 3-way or 4-way functions. Sizes 3/8" to 2" up to 10,000 psi. Design conforms with J.I.C. specifications.

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Pressure compensating and non-compensating types available. 1/4" to 2" sizes. Pressure compensating valves are ideal for Meter In, Meter Out or Bleed-Off control of accurate oil flow.
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A complete line including Relief, Sequence, Counterbalance, Resistance and Counterbalance and Pressure Reducing Hydraulic Valves. Sizes 3/8" to 1 1/4". 100 to 1500 psi pressure range.

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Circle 605 on Page 19

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Circle 607 on Page 19

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by John D. Vandenberg and C. Thomas Goldsmith

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THE ENGINEER'S Library

Recent Books

Nondestructive Testing Handbook. *Edited by Robert C. McMaster; 1765 pages total, 6 by 9 in., clothbound; published by Ronald Press Co., 15 East 26th St., New York 10, N. Y.; available from* MACHINE DESIGN, *$24.00 postpaid for the two-volume set.*

Fundamental principles, methods, applications, equipment, and techniques for all major nondestructive tests are explained and described in detail in these two volumes. Guides are given for interpreting test indications and evaluating serviceability of the test object. Various tests are designed to improve performance reliability, cut costs, insure product quality or uniformity, increase utilization of materials, and reduce breakdowns and accidents.

Significant properties can be measured and discontinuities can be detected without impairing product usefulness. Discussed are such methods as penetrating radiation tests, ultrasonic and sonic tests, magnetic-particle tests, electromagnetic tests, liquid-penetrant tests, and electrified-particle tests.

Engineering. *By Edward H. Robie; 36 pages, 6 by 9 in., paperbound, stapled; published by and available from Bellman Publishing Company, P. O. Box 172, Cambridge 38, Mass.; $1.00 per copy.*

This booklet provides information for those connected with guidance activites in engineering wherever general counseling work is conducted and for individual reference purposes in the choice of a career. Training, opportunities, earnings, etc. are discussed.

Design of Industrial Exhaust Systems. *By John H. Alden; 256 pages, 6 by 9 in., clothbound; published by The Industrial Press, 93 Worth St., New York 13, N. Y.; available from* MACHINE DESIGN, *$6.00 per copy postpaid.*

This third edition presents new information concerning fog filters,

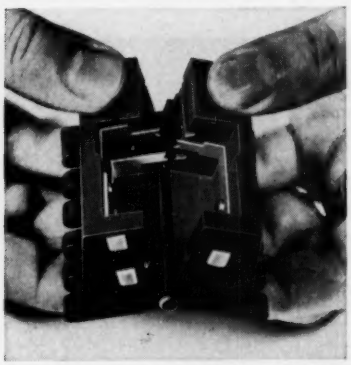
PRODUCT-DESIGN BRIEFS FROM DUREZ

- Fire-safe umbrella roof
- Plastic for toughest electrical jobs
- Where to get ideas

Speaking of Stability

This is one piece of a small roomful of high-class electronic hardware.

The hardware represents man's latest and most sophisticated effort to cram into 123 square feet of floor space the means of discovering in one day which of 15,000 small semiconductors will work in a given set of circumstances, and which ones won't.



STROMBERG-CARLSON

This piece carries the semiconductor through the test gantlet. Around and around it goes, over six electrical-test hurdles, through an oven at a blistering 200°C, and back again for another trip.

Few materials have what it takes to survive this merry-go-round with virtually no change in size, shape, strength, toughness, and insulation values. Here you see one that does—a Durez diallyl phthalate molding compound filled with glass roving.

This is just one of the family. As a class, Durez diallyl phthalate compounds offer unsurpassed freedom from cold flow and creep, high reproducible arc resistance, a chilly indifference to moisture.

You get more information on them by talking over the intended application with your molder. He can describe them far more glowingly than do our data sheets, which we'll gladly send you.

Symbol

When promoters of the American National Exhibition in Moscow displayed a cross-section of America in old Sokolniki Park under flaring umbrellas of glass fiber and Hetron,® they built even better than they knew.

For the tapering 16-foot columns arching into 15,000 square feet of fire-resistant roof, architect George Nelson used our Hetron polyester. One of the reasons: Hetron does not support combustion; it requires no additives, as do other polyesters, to make it resist fire.

OWENS-CORNING FIBERGLAS CORP.

Another reason: strength. Structural engineers learned that winds in Moscow sometimes reach 60 mph. So they tested five of the lily-like umbrellas at Mitchell Field, N. Y., by blasting them with 60-plus-mph gusts from the twin propellers of an Air Force bomber.

The payoff: a coup for the U. S. when a sudden Moscow storm caused aluminum arches to buckle badly in the sparsely attended Soviet exhibition next door. In the jam-packed U. S. showcase, Hetron stood fast.

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That's the virtue of our modest little bimonthly bulletin, *Durez Plastics News*. It starts ideas.

It discusses products, from closures to computers, from plastic portholes to potentiometers. It shows you how Durez plastics are used.

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We'd like to send *Durez Plastics News* to you. May we? If you'd like to receive it regularly, just check the coupon.

For more information on Durez materials and services mentioned above, check here:

- ☐ Data file on Hetron, including list of fabricators
- ☐ Diallyl phthalate molding compounds (data sheets)
- ☐ *Durez Plastics News* (bimonthly bulletin)

Clip and mail to us with your name, title, company address. (*When requesting samples, please use business letterhead.*)

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HOOKER CHEMICALS PLASTICS

Circle 608 on Page 19

R B&W FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

Technical-ities

By John S. Davey

The strength of nuts

With a hard, heat treated nut, ability to plastically adjust and distribute load over many threads diminishes. High loads tend to concentrate on first thread severely enough to cause stripping . . . or fracture of first thread, which causes locking. Nut then cannot increase tension in bolt.

Untreated nuts are strong enough for most needs, and don't pose this problem.

A CAUSE OF STRIPPING

Upon tightening, a nut both compresses and dilates. Dilation can be overcome by wall thickness only, not by added height or heat treatment.

Dilation is important since a reduction in area of bolt under tension accompanies it. Threads pull away from each other, from their stronger base to weaker tips. The shallowness of *fine* threads can cause progressive shear.

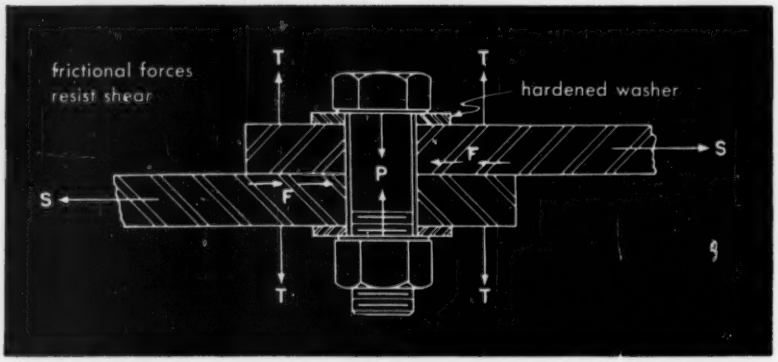
That's why High Nuts (with fine threads) are no answer where "Heavy" Nuts (with coarse threads) are.

WRENCHING STRESS HIGHEST

Rotation of nut produces both tension and torsion in bolt. The force applying this combined stress is about 20% greater than the load which must be sustained when rotation stops.

Thus . . . if a nut hasn't failed in wrenching, it can still withstand at least 20% more direct pull than it sustained during the tightening.

Why high strength bolts make superior joint for dynamic loads



Washers prevent crushing under head and nut with consequent grip relaxation.

While fasteners must be strong enough to carry the calculated loads, what makes a *joint* truly strong is the *residual tension* after wrenching.

NO SLIP OR SEPARATION

Consider the simple lap joint in sketch. Practically rigid, this joint is subjected only to: (1) external tension forces "T" tending to separate the plates against bolt clamping force "P"; (2) shear forces "S" tending to make plates slip against friction resistance "F".

"F" increases when "P" does. With enough clamping force applied, shear loads transfer from one plate to the other without slippage. And when clamping force always exceeds tensile forces, plates obviously *cannot* separate. There can be no further stretch on bolt. Its load stays static at preload "P", even when external loads are dynamic.

UNIFORM CONTROL OF PERFORMANCE

RB&W high strength bolts allow a high magnitude of clamping force to be applied . . . and *uniformly* so. Materials conform to ASTM specifications. Applying known torques to nut produces uniform bolt tensions. Riveting by contrast, depends on difficult-to-control variables.

MORE STRENGTH OVERALL

For shear-resistance, riveted joints offer only the actual rivet shear strength. Don't count too much on friction even though rivets exert some grip as they cool. Compare: a 1-inch bolt tightens to a tension of 42,000 lbs; a 1-inch rivet develops 22,000 lbs at best.

The higher residual tension does more than make a joint much stronger in shear and in tension. It also protects the bolt against fatigue caused by stress-reversing cycles such as vibration; keeps the bolt from loosening, too.

All this explains why, under heavy dynamic loads, rivets can loosen, elongate holes, often fail, requiring difficult replacement; but high strength bolts stand up. They can keep connections permanently tight on vibrating machinery, heavy duty conveyors, and transportation equipment.

Talk it over with an RB&W fastener expert. Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N. Y.

RB&W high strength bolts are from selected grade of medium carbon steel with proper combination of ductility and tensile strength; conform to ASTM A325.

Plants at: Port Chester, N.Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

reverse flow filters, venturi scrubbers, and increased application of multiple miniature cyclones. How to design, build, or buy an exhaust system that will adequately and economically perform the functions required by law or prescribed by specialists is also covered. Other topics are exhaust ventilation, low-pressure pneumatic conveying, hood design, piping and structural details, and selection of dust separators and exhaust fans.

Association Publications

Soldering Manual. 170 *pages, 6 by 9 in., clothbound; available from American Welding Society, 33 West 39th St., New York 18, N. Y.; $5.00 per copy.*

After principles of soldering are reviewed, solders, fluxes, and joint design are discussed. Surface preparation, processes and procedures, flux residue treatment, and inspection and testing are also covered. Soldering techniques are given for the different base metals and alloys of copper, steel, nickel, lead, aluminum, magnesium, and tin. Latest soldering information and methods are also presented for cast iron, precious metal coatings, and printed circuits.

Government Publications

OTS Technical Reports. Copies of reports listed below are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.

PB 151068. Physical and Mechanical Properties of Nine Commercial Precipitation-Hardenable Stainless Steels. By D. A. Roberts, D. B. Roach, and A. M. Hall, all of Battelle Memorial Institute; 83 pages, 8½ by 11 in., paperbound; $2.25 per copy.

Data for martensitic (W and 17-4PH), semi-austenitic (17-7 PH, PH 15-7 Mo, AM 350, and AM 355), and austenitic (A-286, 17-10P, and HNM) types of steels are given. Typical properties obtained with recommended heat treatments are reported. Data on properties resulting from modified treatments are also included. Merits of various steels and validity of test data are not evaluated.

PB 151069. Properties of Certain Cold-Rolled Austenitic Stainless Sheet Steels. By R. J. Mangone, D. B. Roach, and A. M. Hall, all of Battelle Memorial Institute; 62 pages, 8½ by 11 in., paperbound; $1.75 per copy.

Physical and mechanical properties of five steels for airframe construction are presented. Data for AISI Types 201 and 301, USS Tenelon and 17-5 Mn V, and MicroMach are given.

PB 151650. Research and Development Report on Sparking Characteristics of Metals. By Geo. J. Dashevsky, New York Naval Shipyard; 18 pages, 8 by 10½ in., paperbound, side-stapled; $0.50 per copy.

Tests of steel, copper, brass, bronze, and aluminum in an explosive atmosphere are described. Data obtained were used as a basis for establishing sparking-test requirements for nonsparking tools.

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The double micrometer dial permits 1200 accurate, visual settings over entire dial range. Set this timer for 18 minutes 6 seconds or any other exact time setting required.

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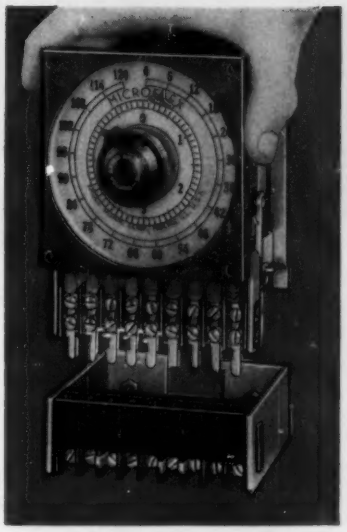

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Please send FREE Bulletin 110 containing complete data on Microflex Reset Timers.

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Circle 610 on Page 19

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A "SHEAR-SEAL" VALVE

for LESS than a spool valve

RATED FOR 3000 P.S.I. OIL SYSTEMS

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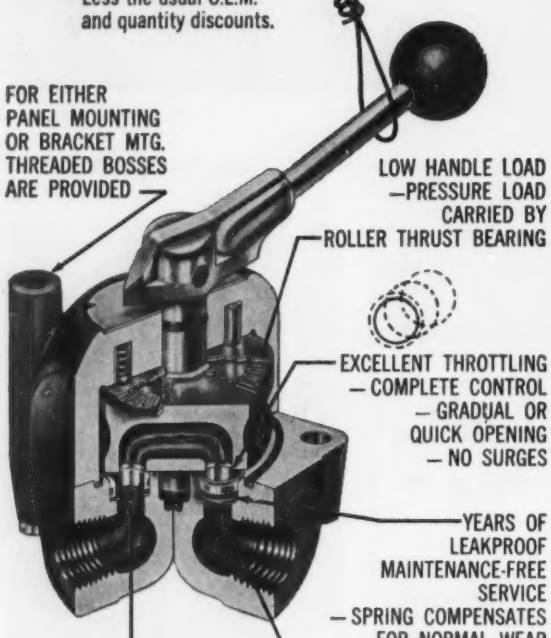
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MORE FLOW THRU UNOBSTRUCTED ROUND FLOW PASSAGES
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Professional Viewpoints

. . . progress in Pyroceram . . .

To the Editor:

The article, "Progress in Pyroceram" (MACHINE DESIGN, August 20, 1959), was most informative; it provided valuable data for giving proper direction to the design approach. I have given much thought to high-temperature, antifriction bearings and to ball-bearing fabrication in general. I am prompted, therefore, to express a few ideas and proposals on the subject of

Pyroceram Ball-Bearing Design and Fabrication For High-Temperature Application

Considerable research is being done to evaluate the use of ceramics in ball bearings, particularly for high-temperature application. Specifically, Corning's crystalline ceramic, Pyroceram, appears to be the material of immediate interest. In addition to the many desirable properties of Pyroceram for use at high temperatures, the material's dielectric properties also warrant further investigation from the viewpoint of ball-bearing fabrication. The electrical nonconductivity of Pyroceram affords some interesting bearing manufacture design possibilities.

In the case of low-temperature ball-bearing manufacture, for example, consider the combination of metal raceways and Pyroceram balls. It is conceivable that the inner (or outer) raceways could be in two sections, Figure 1*a*. These identical half-raceways could be

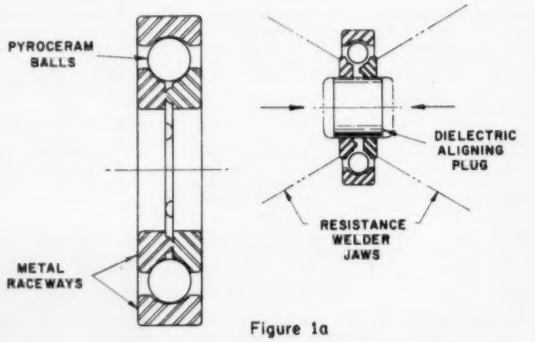
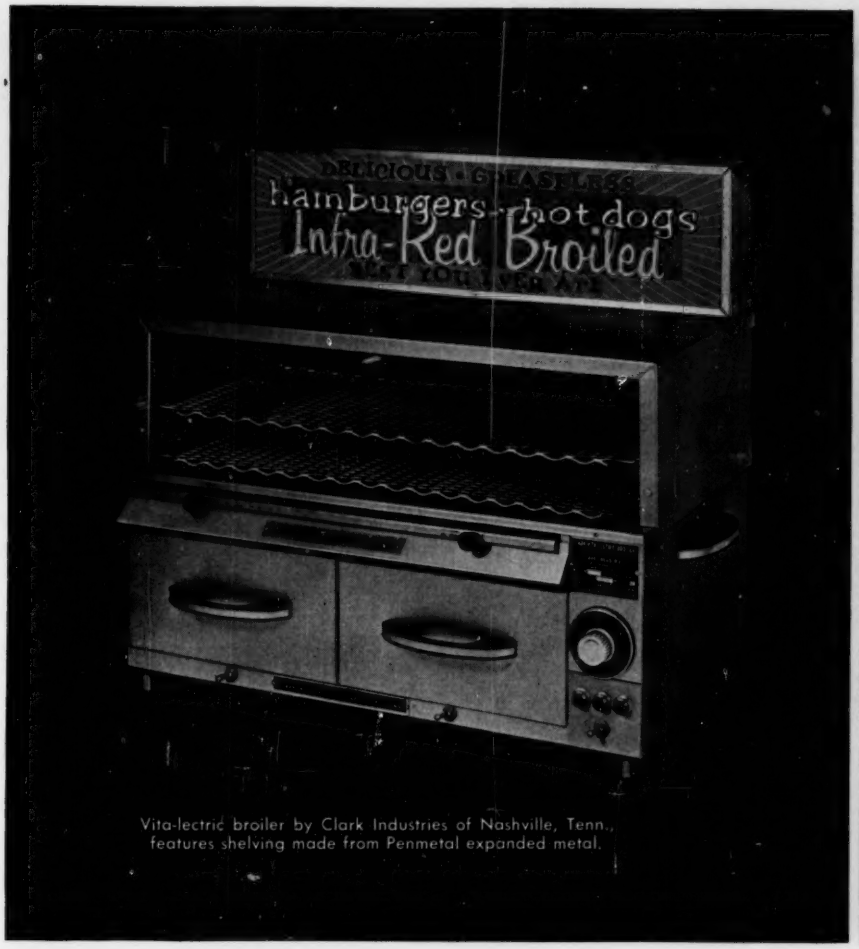


Figure 1a

formed by various methods to include three equally spaced convex or conical button-like protrusions on the inside face normal to the bearing axis. Assembling two of these half-raceways face to face on a dielectric aligning plug, and radially displacing 60 deg effects



Vita-lectric broiler by Clark Industries of Nashville, Tenn., features shelving made from Penmetal expanded metal.

HANDSOME, HARDY SHELVING

still another use for Penmetal expanded metal

To appreciate why Penmetal expanded metal is becoming more and more popular with designers, note the advantages gained from its use as shelving for the Clark Vita-lectric broiler.

Grease and food particles are easily removed from the *flattened* expanded metal with nothing more than a spatula. Complete cleaning can be accomplished with warm water and soap. The open diamond mesh stands up under heat and heavy use—imparts a smartness that cannot be denied. Cost: Surprisingly little.

Comes in flattened or standard form; in carbon steel, aluminum, stainless steel or other corrosion-resistant metals; large or small mesh; light or heavy gauge. Readily cut, shaped and welded.

Send for catalog 515-EM, which describes Penmetal expanded metal in detail, and suggests a number of ways you might use this versatile material.

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Penmetal 1849

a name to remember

Expanded metal is used in the broiler drawers, too.

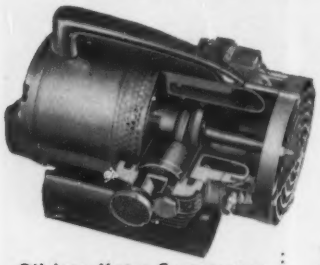
PM-201

Circle 612 on Page 19

Oil-Free COMPRESSED AIR FROM YOUR CHOICE OF 58 MODELS

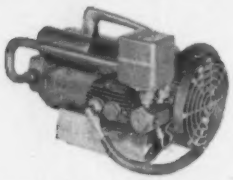
Completely oil-free air—no lubrication ever needed when you choose one of these 58 B&G Oil-less Compressors. Carbon graphite piston rings and skirts need no lubrication—motor bearings are *permanently* lubricated. Numerous other design and construction features assure long life and smooth dependable delivery of cleaner, cooler, drier air.

For portable or built-in applications, these lightweight, compact compressors give maximum air per horsepower.

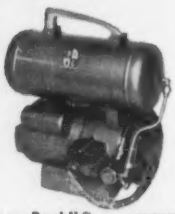


Oil-less Motor Compressor Units—35, 75 and 175 lb., single and two-stage, ¼ to ¾ H.P.

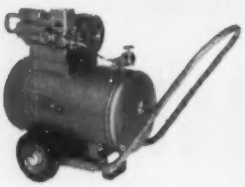
Bare Compressor (less Motor)—35, 75 and 175 lb. pressures, for belt-driven applications.



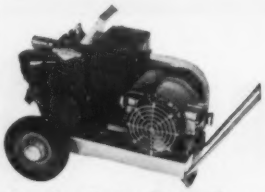
Tankless Motor-Compressor Outfits—for use where existing air tanks or pipe lines provide air storage. 35, 75, 175 lbs., single and two stage. ¼ to ¾ H.P.



"Piggy-Back" Compressor Tank—Handy 2-gallon tank mounts on any B&G 75 or 175 lb. Motor Compressor or Tankless Outfit.



10-Gallon Air Tank Motor-Compressor Outfits. 35—175 lbs.—mounted on Code or non-Code Tanks. Portable when cart-mounted.



Gasoline Engine-Driven Compressor Outfits—Weighs only 55 lbs., compact, cart-mounted. Delivers air up to 90 psig. continuously.

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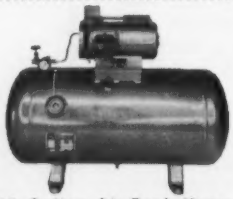

30-Gallon Air Tank Motor Compressor Outfits—75 and 175 lb. units. Vertical or horizontal ASME Code tanks tested to 400 lbs. ¼ to 1½ H.P.

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a total of six point contacts between the half-raceways.

The idea here is to use existing resistance-welding techniques and apparatus to permanently join the half-raceways through the welds which take place through the six high-resistance point contacts. Since the Pyroceram balls and the aligning plug are nonconductors, the electrical path must necessarily be through the high-resistance point contacts. Also, variation of the resistance welder "jaw" pressure could conceivably be a precise control of "built-in" bearing clearances.

Projecting these ideas to high-temperature ball-bearing design may require a slight modification. In a high-temperature ball bearing, again using metal raceways and Pyroceram balls, it is probable that the alloy chosen for the metal raceways would exhibit poor resistance-welding properties. It would then be expedient to add another high-temperature metal member with good resistance welding characteristics, Figure 1*b*.

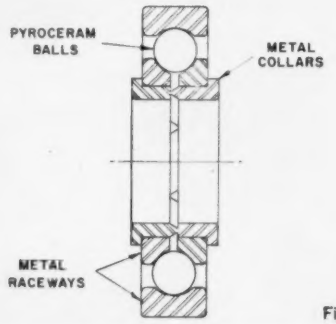

Figure 1b

This modification takes the form of two identical half-collars, again having the three convex or conical protrusions. These half-collars would be press-fitted into their respective half-raceways. Again the resistance weld takes place at the six high-resistance points, but now in the half-collars instead of the half-raceways. As before, the built-in bearing clearance methods would be used. It may also be advisable to flush the bearing assembly with an inert gas during the weld operation to avoid contamination of the balls and raceways.

Mr. Rosenberg's article ("Progress in Pyroceram") discussed the friction problem involved in the ball separating retainer. Indeed, the retainer can be said to defeat the purpose of a ball bearing in that it necessarily means sliding friction in a bearing based on the rolling friction principle. This problem becomes paramount in high-temperature bearings.

A unique solution to this problem was first brought to my attention by a German patent. The disclosure is based on three rows of balls and a "floating" raceway. The design is straightforward and certainly represents a true rolling-friction, retainerless ball bearing compatible with either low or high-temperature bearing design. Figure 2 illustrates this idea with modifications to reduce the over-all bearing diameter and

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Finally, finishing begins with prime coating. Often multiple finish coats. Then, baking. Through this sequence is inspection and re-inspection all along the way.

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Write and describe your product. See how Clad-Rex can work its broad effect on your manufacturing methods and costs. No obligation, of course.

COMPARISON OF FABRICATING PROCEDURE

Unfinished Sheet Metal	Clad-Rex Vinyl-Metal Laminate
FORMING	FORMING
CLEANING	CLEANING
INSPECTION	INSPECTION
GRINDING, ETC.	
INSPECTION	
SUB-ASSEMBLY	SUB-ASSEMBLY
INSPECTION	INSPECTION
CLEANING	
BONDERIZING	
INSPECTION	
FINISHING (multiple coats as required)	
INSPECTION	
STRIPPING of rejects	
REFINISHING	
INSPECTION	
FINAL ASSEMBLY	FINAL ASSEMBLY
INSPECTION	INSPECTION
STRIPPING of rejects	
REFINISHING	
INSPECTION	
RE-ASSEMBLY	
INSPECTION	
SHIPPING	SHIPPING

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to facilitate construction by the previously described techniques. Adjacent rows of balls automatically space each other, and all balls are in contact with each other and their respective raceways.

Note that by placing the "floating" raceway at the "inside" position, the weld area is essentially covered, thereby shielding the balls and raceways from contamination by the weld refuse. The floating race is also unique in that it is free to rotate at whatever velocity demanded and may be considered an elastic member in the sense that it tends to "smooth out" irregularities

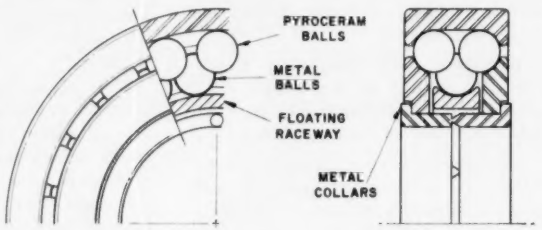


Figure 2

and disturbances in the rest of the system.

Projecting the theory still further, the ultimate high-temperature antifriction bearing would be a retainerless roller bearing. Besides having a much greater load-carrying capacity, a properly designed retainerless roller bearing would exhibit far greater planar directionality and antiskid control of its rolling members.

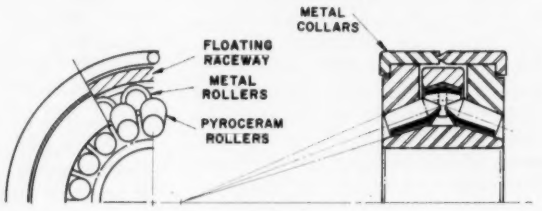


Figure 3

Figure 3 illustrates a possible design solution. At the "outer" position shown, the floating raceway will be under tension loads. It would then be advisable to insure that the floating raceway so positioned would be a metal member. The outside rows of rollers would be of Pyroceram, and the previously described welding techniques for bearing assembly could be applied.

These are but a few ideas made possible by the use of Pyroceram as a bearing material. Far more revolutionary design solutions are sure to come.

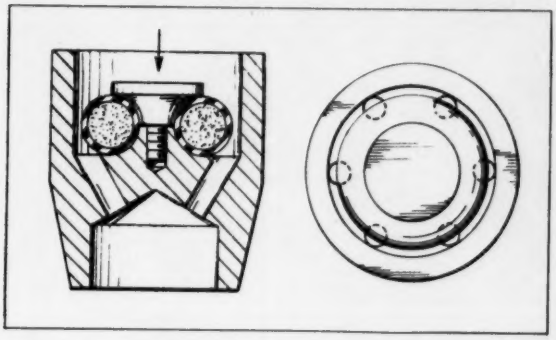
GEORGE R. HUARD JR.
Palo Alto, Calif.

NOTEWORTHY

Patents

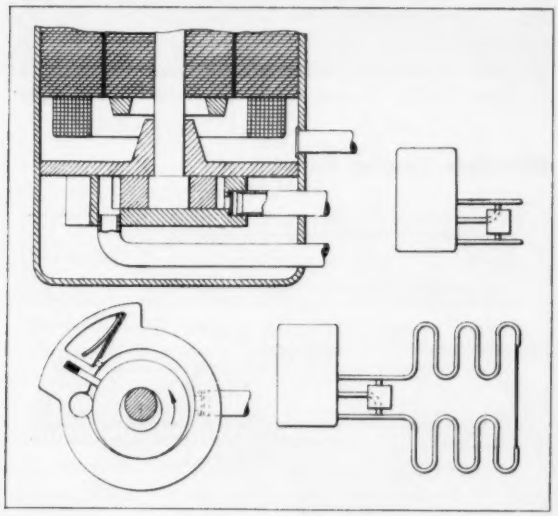
Thermostatic Flow-Control Device

Installed in a fluid line, a device with only one moving part regulates flow according to the temperature of the fluid. The moving part is an elastic envelope, toroidal in shape and filled with material which



expands with heat. An envelope-confining member holds the toroid in place over a number of outlet passages. As temperature rises the toroid expands until the outlet passages are completely blocked. *Patent 2,902,222 assigned to American Radiator & Standard Sanitary Corp. by Thomas E. Noakes.*

Constant-Power Rotary Compressor



By-pass circuit in a rotary gas compressor automatically changes effective compressor displacement so that power input remains constant under fluctuating loads. Function of the by-pass arrangement is the same for

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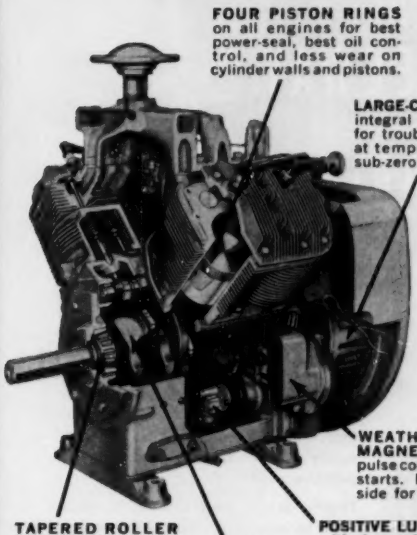
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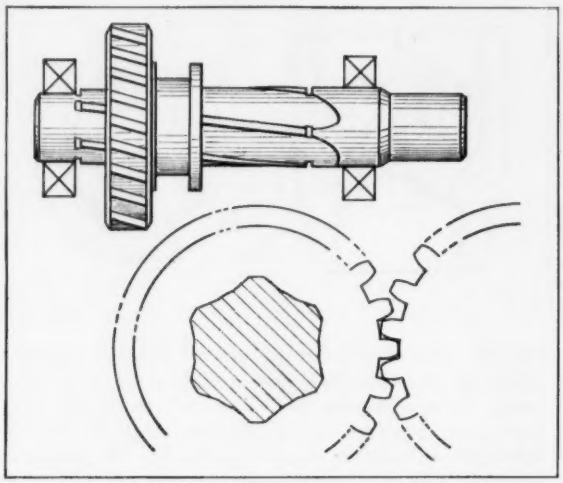
both directions of gas flow in the main circuit. The line includes a one-way pressure-actuated check valve and connects to the high-pressure chamber of a rotary compressor. Outside the compressor, the by-pass line is connected to either the suction or discharge lines. *Patent* 2,904,973 *assigned to General Electric Co. by Milton M. Kosfeld.*

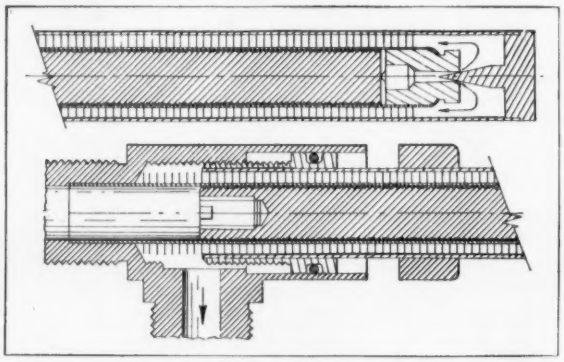
Load-Locked Helical-Splines

Flat sectional shape of helical spline teeth provides friction locking action to prevent axial motion under load. Designed for use with conventional sliding helical gears, the spline construction prevents the gears

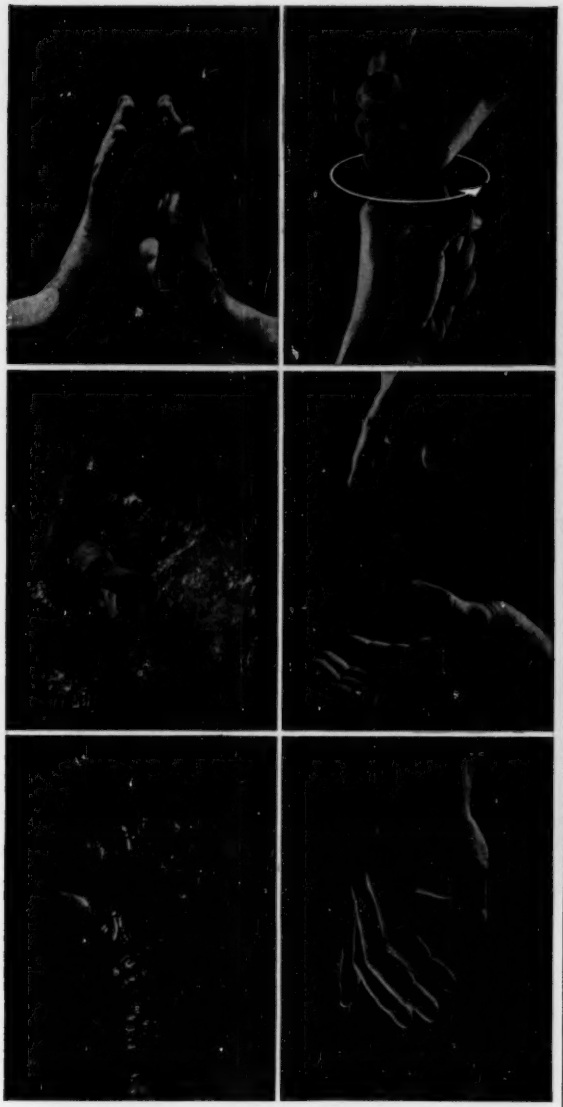


from creeping out of mesh due to axial load components developed during operation. The flat design of spline teeth provides inclined planes which wedge against corresponding planes in the gear hub and thus hold the gear in place. The greater the loads, the greater the wedging force. *Patent* 2,905,006 *assigned to Dana Corp., Toledo, Ohio, by Robert W. Wagner.*

Miniature Cooling Unit



Intense cooling of small surfaces or areas is provided by an assembly of concentric tubes. A helical channel for incoming refrigerant gas at high pressure is formed



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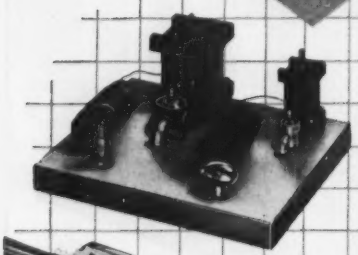
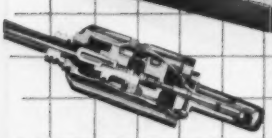
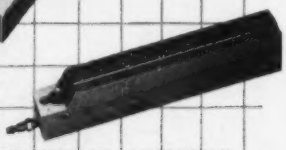


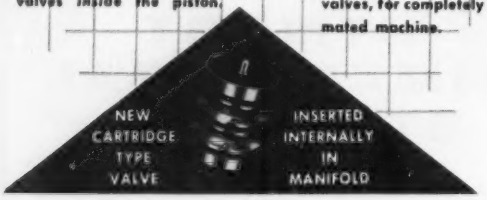
⅛" valves inserted in special hand controls, to valve air signals for instantaneous operation of piloted valves in remote locations.



Double action cylinder with all manually operated valves *inside* the piston.



10-valve manifold using piloted ¼" and ⅜" insert valves, for completely automated machine.



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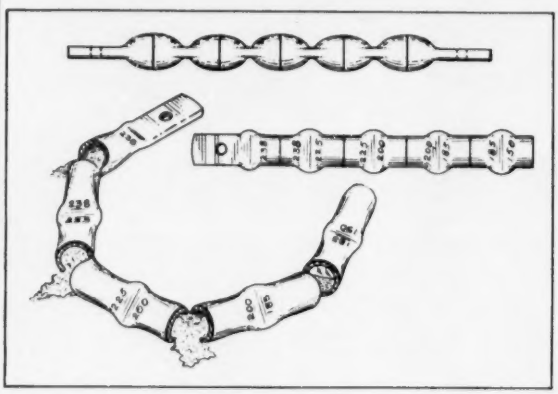
by a solid threaded core encased by a tube tightly fitted on the crests of the threads. A needle-type expansion valve at the outlet end of the core controls gas flow. Low-pressure gas from the needle valve flows to final outlet through another helical channel which has a larger diameter than the first and is formed of spiral-wound strip. *Patent* 2,909,908 *assigned to Arthur D. Little, Inc., Cambridge, Mass., by Alexis Pastuhov and Francis J. Zimmermann.*

Maximum-Temperature Indicator

Irreversible indication of temperature is provided by a segmented tube filled with calibrated mixtures of fusible material. The mixtures are compounded to



fuse in a graduated range of temperatures which can be marked on the tube. Each mixture is separated from the others by crimps in the tube. To determine maximum temperature experienced, beads are broken open. Maximum temperature lies between the "highest" fused mixture and the "lowest" unfused mixture. *Patent* 2,909,925 *assigned to Chance Vought Aircraft Inc., Dallas, by Richard H. Myers.*

Impact-responsive valve closes a liquid line when the line is subjected to severe external shock or displacement. Inside the valve are two shafts held butted together by spring force. The same force holds a flat valve cap normally open on the shaft at the inlet end of the valve. Shock unseats the butted ends of the shafts, allowing the cap to seat and stop flow. Abnormal shock loads will carry away an intentionally weakened outlet boss on the valve and one of the shafts. Under less severe shocks, the valve can be reset. *Patent* 2,910,080 *assigned to Tokheim Corp., Fort Wayne, Ind., by George W. Wright and John C. Kerr.*

Copies of patents briefed in this department may be obtained for 25 cents each from the Commissioner of Patents, Washington 25, D. C.

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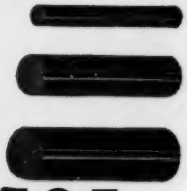

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SEAL SIDE
2
Thread pipe or fitting 3 threads into port. Point in desired direction.
3
Tighten Tru-Seal to complete leakproof assembly (only light torque required).

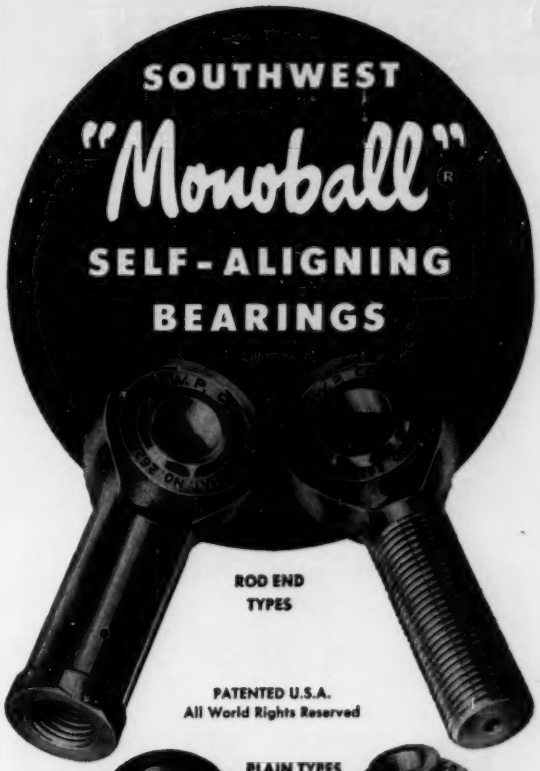
TRU-SEAL DIVISION
FLICK-REEDY CORPORATION

7N016 York Rd. Bensenville, Ill.

"Miller Fluid Power" is also a Div. of Flick-Reedy Corp.

Circle 622 on Page 19

SOUTHWEST "Monoball"® SELF-ALIGNING BEARINGS



ROD END TYPES

PATENTED U.S.A.
All World Rights Reserved

PLAIN TYPES

CHARACTERISTICS

	ANALYSIS	RECOMMENDED USE
1	Stainless Steel Ball and Race	For types operating under high temperature (800-1200 degrees F.).
2	Chrome Alloy Steel Ball and Race	For types operating under high radial ultimate loads (3000-893,000 lbs.).
3	Bronze Race and Chrome Steel Ball	For types operating under normal loads with minimum friction requirements.

Thousands in use. Backed by years of service life. Wide variety of Plain Types in bore sizes 3/16" to 6" Dia. Rod end types in similar size range with externally or internally threaded shanks. Our Engineers welcome an opportunity of studying individual requirements and prescribing a type or types which will serve under your demanding conditions. Southwest can design special types to fit individual specifications. As a result of thorough study of different operating conditions, various steel alloys have been used to meet specific needs. Write for Engineering Manual No. 551. Address Dept. **MD-M59**

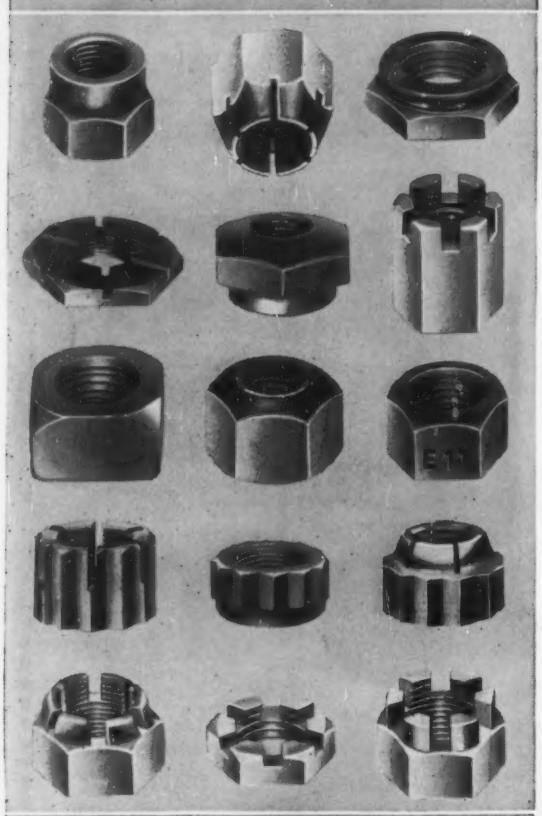
SOUTHWEST PRODUCTS CO.
1705 SO. MOUNTAIN AVE., MONROVIA, CALIFORNIA

Circle 623 on Page 19

SPECIAL NUTS

to specs. 7/16"—4¼" cross flats

special machines + large stock of material × years of experience = speedy deliveries high quality low prices



Here are a few samples made to customers specifications . . Our batteries of special high-speed multi-spindle, automatic machines make possible fast and accurate production of hexagon nuts of non-standard height and special shape from carbon or alloy steel, Nuval bronze or other non-ferrous metals; also AN 310 through AN 335 as per latest Airforce specifications. Very often the special nut you require may be similar to one we are already making and a simple modification would result in a price advantage and quicker deliveries to you . . Send us your blueprint and particulars —let us quote on your requirements . . We also have a catalog that contains complete specifications, engineering data and prices regarding our standard nuts.

Manufacturer of Standard and Special
12 Pointer, Square and Hexagon Nuts
. . . "Huglock" and "Conelock" locknuts.

NATIONAL MACHINE PRODUCTS COMPANY

an SPS company 44250 UTICA ROAD UTICA, MICH

Circle 624 on Page 19

MAYLINE

STANDARD TABLE

Pedestal Drafting Tables For Small Shop Requirements!

Mayline has several pedestal type tables in top sizes of 24" x 36" and 30" x 42". Tool drawer can be attached to all tables. An ideal unit for the small drafting room or that extra table. All tables described in Folder S-17. Send for your copy today.

Symbol of MAYLINE Superiority

MAYLINE CO.
601 NO. COMMERCE ST.
SHEBOYGAN, WISCONSIN

V-MODEL TABLE

MAYLINE

Circle 625 on Page 19

If your plant is in this area . . .

DOLLIN DIE-CASTING
• Service
• Quality
• Economy
are as close as our local representative

① Boston ② Buffalo ③ Irvington, N. J. ④ Philadelphia ⑤ Greensboro ⑥ Louisville ⑦ Memphis ⑧ Miami ⑨ Canton ⑩ Detroit ⑪ St Paul ⑫ Chicago

When you have a die-casting design problem—a part for discussion—a print for quotation, call in your local DOLLIN representative. He can give you on-the-spot help and place at your service the vast experience and facilities of the DOLLIN engineering staff and plant to supply the most practical, economical answer.

DOLLIN die-casting service is comprehensive and complete. It includes engineering assistance . . . big, modern plant . . . die-making . . . high-production equipment . . . rigid inspection . . . dependable delivery.

Submit prints or samples of parts for engineering advice and quotation, without obligation. Write for 16-page brochure showing DOLLIN facilities and services.

DOLLIN CORPORATION
612 So. 21st St., Irvington 11, N. J.

DOLLIN DG
Zinc and Aluminum
DIE-CASTINGS

Circle 626 on Page 19

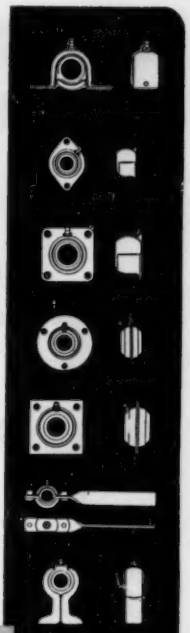
TRIANGLE

SELF-ALIGNING
SLEEVE TYPE
BEARINGS

STANDARD▲
OR
◀SPECIAL

Routine or unusual — let us help with your bearing or bearing mounting problems. 20 years' experience furnishing new ideas and quality bearings at low cost to leading mechanical equipment manufacturers.

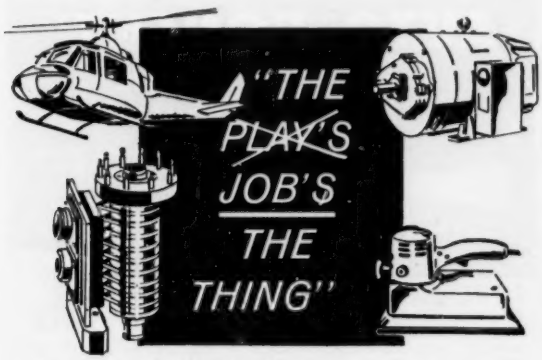
Creative design and engineering...
making our products better today . . . so yours may be better tomorrow.



TRIANGLE
MANUFACTURING COMPANY
736 DIVISION ST. • OSHKOSH, WISCONSIN

WRITE FOR NEW 40-PAGE CATALOG

Circle 627 on Page 19



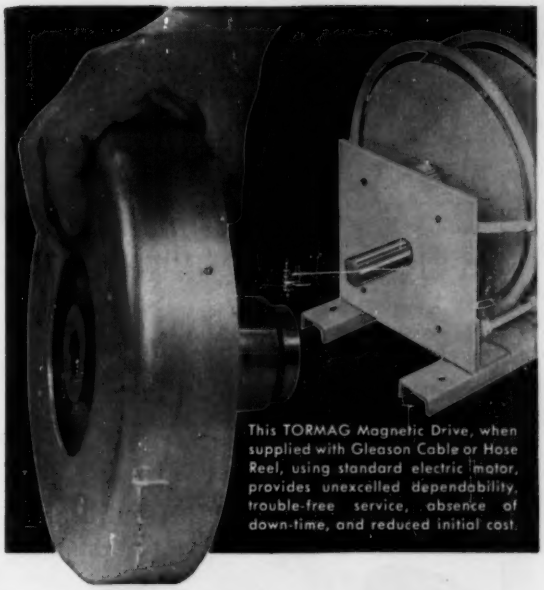
That's what counts! Drawing upon literally hundreds of Superior brush grades and contacts, our responsibility is to fit your job *exactly*, whether on original equipment or in maintenance. The Superior representative will make sure that you get the very utmost in performance and long life. Forty years' experience goes into his recommendation and ours.

Ask for "Get the Most Out of Your Carbon Brushes"

SUPERIOR CARBON PRODUCTS, INC.
9115 George Avenue, Cleveland 5, Ohio

Since 1919 Superior CARBON BRUSHES

Circle 628 on Page 19


This TORMAG Magnetic Drive, when supplied with Gleason Cable or Hose Reel, using standard electric motor, provides unexcelled dependability, trouble-free service, absence of down-time, and reduced initial cost.

GLEASON HOSE OR CABLE REELS
with TORMAG
MAGNETIC COUPLING

offer

UNEXCELLED DEPENDABILITY
ABSENCE OF DOWN-TIME
FASTER DELIVERY
CONTINUOUS FULL STALL
LOWER INITIAL COST
SHOCKLESS DRIVE
TROUBLE-FREE SERVICE

Tormag Magnetic Coupling is an exclusive first on Gleason Reels. It is a frictionless drive that delivers controlled torque and will operate in partial or continuous stall at all times with no damage to motor or coupling.

Tormag is available only on Gleason Cable and Hose Reels. Patents Applied For on use of Tormag with Hose or Cable Reels. Write for information on Tormag.

Gleason Reel Corp
Dept. B, 800 Horicon St., Mayville, Wis.
SPRING REEL HEADQUARTERS FOR ALL INDUSTRY

Circle 629 on Page 19

YOU CAN RELY ON OUR DESIGN-ENGINEERING SERVICE... EXTENSIVE PRODUCTION FACILITIES ...DEPENDABLE PROMPT DELIVERY SCHEDULES WHEN YOU ORDER

NATIONAL LOCK

FASTENERS AND COLD-HEADED PRODUCTS, STANDARD OR SPECIAL-PURPOSE...THEY'RE DESIGNED TO YOUR SPECIFIC REQUIREMENTS AND ENGINEERED TO COST YOU LESS!

NATIONAL LOCK COMPANY
ROCKFORD, ILLINOIS
FASTENER DIVISION

Circle 630 on Page 19

AJUSTRITE®
CHAIRS AND STOOLS

DRAFTING CHAIR *Model RUC-2230*

- 2 inch upholstered seat
- full swivel seat
- 2-way adjustable backrest
- no soiled hands when adjusting seat
- Three sizes: 20" to 28"—24" to 32"—28" to 36"
- Gray, green, beige or brown finish

Also available with round metal or wood seat; or formed plywood or solid hardwood saddle seat.

FREE TRIAL

Use an AJUSTRITE chair or stool for 30 days without obligation. Prove to yourself the many advantages AJUSTRITE offers in comfort, utility and economy. Write today—we'll do the rest.

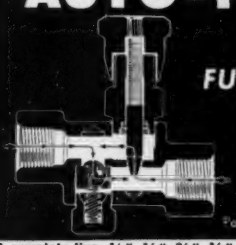
10 YEAR GUARANTEE

32 Models for Factories • Schools • Laboratories • Hospitals • Offices

AJUSTO EQUIPMENT CO.
515 CONNEAUT ST. · BOWLING GREEN, OHIO

Circle 631 on Page 19

AUTO-PONENT®
HYDRAULIC
***FULL FLOW* VALVES**
Flow Control, Needle, Check, for HYDRAULIC Power



Model KF Flow Control Valve with Dial and Knob adjustment for direct reading and duplicating reference. Now available in Aluminum for 3000 psi.

Pat. #2,841,174

A complete line: 1/8", 1/4", 3/8", 1/2", and 3/4" female Dryseal Pipe Sizes in all models and types. Equivalent Aeronautical Tube Sizes on special order.

MINIMUM PRESSURE DROP AND POWER LOSS . . . Oversize ports and passages give maximum flow at minimum pressure drop, insure greater accuracy and response in hydraulic or large volume air cylinder control.

EASY FLOW ADJUSTMENTS under full pressure. Seal located at port to eliminate air or dirt traps. Gland structure equally effective on pressure or vacuum.

SENSITIVE, CHATTERLESS BALL CHECK . . . Patented design insures rapid ball movement to open or close at low differentials.

FORGED BODIES permit higher pressures with wide safety margins. Aluminum—3000 psi; Steel and Stainless Steel—5,000 psi. Pressure ratings based on better than 5 to 1 safety factor. All internal parts are Stainless. Write for illustrated catalog.

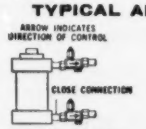
Model F Standard Flow Control Valve or Model N Needle Valve

Model KF Knob and Dial Flow Control Valve or Model KN Needle Valve.

Model PF Knob and Dial Flow Control Valve or Model PN Needle Valve for panel mounting.

Model C Check Valve for In-Line Mounting.

TYPICAL APPLICATIONS



Controlling Double Acting Cylinder

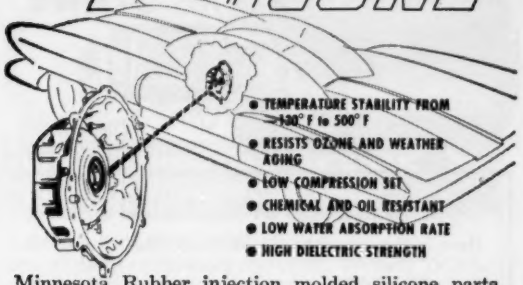
Controlling Single Acting Cylinder

AUTOMATION AUTO-PONENTS INC. COMPONENTS
2925 GRANT STREET
BELLWOOD (Chicago Suburb) ILLINOIS

Circle 632 on Page 19

MINNESOTA MR RUBBER

PARTS MOLDED OF SILICONE



- TEMPERATURE STABILITY FROM −130° F to 500° F
- RESISTS OZONE AND WEATHER AGING
- LOW COMPRESSION SET
- CHEMICAL AND OIL RESISTANT
- LOW WATER ABSORPTION RATE
- HIGH DIELECTRIC STRENGTH

Minnesota Rubber injection molded silicone parts improve operating characteristics on scores of applications such as automatic transmission seals, bellows and molded parts where conditions are exceptionally tough. The exclusive method of injection molding insures absolute uniformity of parts giving the user consistent performance. Minnesota Rubber produces O-rings, QUAD RINGS®, custom molded parts and extrusions out of silicone. In addition, you can specify silicone for Prototypes by Kotokast®. No matter what your requirement, you can be sure of getting the tops in quality and service from Minnesota Rubber.

FOR MORE INFORMATION AND A COPY OF THE SILICONE RUBBER HANDBOOK

MINNESOTA MR RUBBER

WRITE DEPARTMENT 843 3630 WOODDALE AVENUE MINNEAPOLIS 16, MINNESOTA

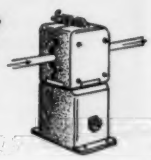
Circle 633 on Page 19

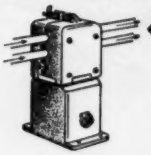
PUMPING IDEAS

POSSIBLE ONLY with a SIGMAMOTOR PUMP

MOVE CORROSIVE LIQUIDS

Material being pumped never comes in contact with pump mechanism. Wave-like motion of steel fingers forces material through Tygon tubing. By changing size of tubing, capacity can be increased or decreased. Pump housing opens for removal and insertion of tubing.



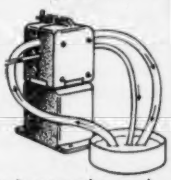


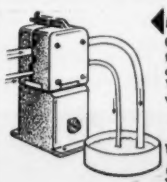
PUMP 2 OR 3 DIFFERENT LIQUIDS SIMULTANEOUSLY

Some models will accommodate up to four tubes so that four different liquids can be passed through the pump at one time without danger of contamination.

FEED AND MIX

One or more tubes can be feeding material to a mix while a larger tube is recirculating the liquid to produce agitation and thorough mixing. Viscous materials can be pumped without danger of gumming or plugging. Remove tube and pump is clean.





METER ADDITIVES

One or more additives can be pumped to a solution in the exact amount desired by selecting the correct size of tubing and regulating pump speed. Various controls can be incorporated to close valves ahead of pump.

Capacities from 0.5 cc. per min. to 4.5 G.P.M.

Write for complete information on sizes and capacities.

SIGMAMOTOR, INC.

26 N. Main Street • Middleport, N. Y.

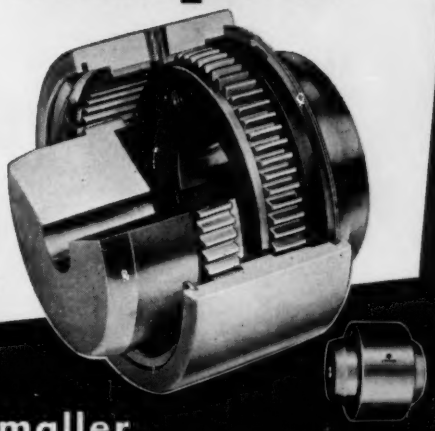
Circle 634 on Page 19

Sier-Bath

FLEXIBLE GEAR COUPLINGS

are

smaller stronger simpler



smaller

Sier-Bath has done away with undesirable weight and inertia by eliminating flanges . . . reducing size as much as 40 percent and cutting weight to half that of flanged types. Such savings in size mean considerably lower cost!

stronger

More horsepower can be transmitted through the one-piece sleeve of the Sier-Bath Coupling than through flanges and bolts. Precision made, smaller gear teeth offer better load distribution. No steel castings are used on Sier-Bath couplings!

simpler

There are only seven parts to the Sier-Bath coupling. It can be assembled or dis-assembled in seconds. Sier-Bath Couplings won't "freeze-up" in corrosive service, even after years of use. Simplicity in design means lower cost to you.

Send for Sier-Bath's general Catalog C-5 and Bulletin N-1 on Nyflex Couplings.

Sier-Bath

GEAR AND PUMP CO., INC.

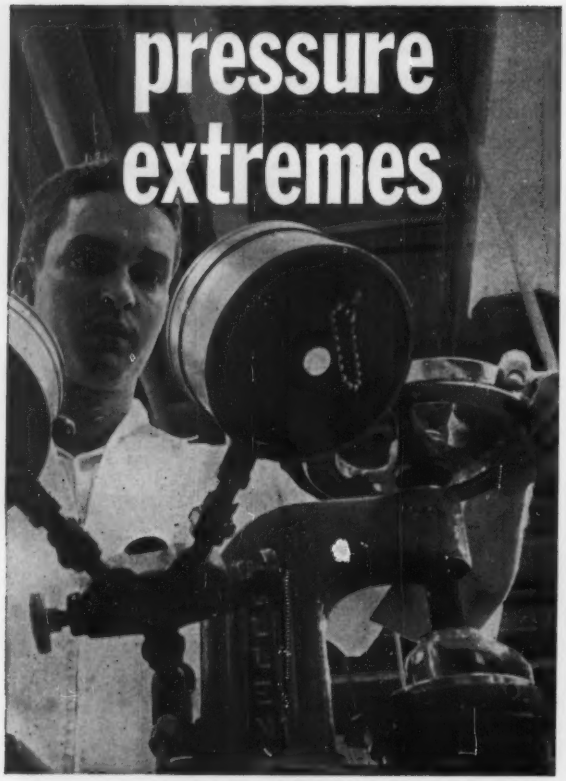
FLEXIBLE COUPLING DIVISION

9254 HUDSON BLVD., NORTH BERGEN, N. J.

Member A.G.M.A. Founded 1905

Circle 635 on Page 19

you don't worry about pressure extremes



The Mullen Burst Test, being run here at our lab in Buena Vista, Virgina, is the yardstick to determine maximum resistance to burst to make certain the material conforms to specifications.

with Reeves Vulcan Diaphragms

One of the numerous inspections in our system of quality control is the Mullen Burst Test. This inspection is used on every roll of coated fabric before it is shipped or made into diaphragms.

From the gross psi readings of this test, we can assure you that Reeves Vulcan Diaphragms will safely withstand the pressures listed in our specifications.

You name the application–we'll supply the right diaphragm or diaphragm material for your specific needs. For prompt action, call or write us today.

REEVES GEM VULCAN RUBBER PRODUCT

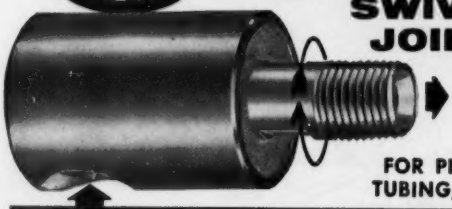
Reeves Brothers, Inc., Vulcan Rubber Products Div. 1071 Avenue of the Americas, New York 18, N. Y.

Circle 636 on Page 19

Here's How to Make Hose Work Better, Last Longer!

BARCO

LOW COST, BALL BEARING SWIVEL JOINT



FOR PIPING, TUBING, HOSE

For Hydraulic or Pneumatic Service

Here is the *new* BARCO SINGLE PLANE SWIVEL JOINT that swivels in one plane only. Ideal for use as a *swivel connector:*

- **Key to Better Engineering!** Small, light, inexpensive. Very low torque under pressure. Neat, space-saving installations. Easy to position lines accurately.
- **Many Uses:** (1) To make piping or tubing movable, flexible! (2) As swivel connectors on hose to eliminate torsional working stresses and long radius bends. Longer hose life! Shorter lengths required!
- **Sealed, Unitized Construction.** Built with ball-bearings. O-ring seal. Choice of styles; sizes ¼", ⅜", ½", ¾". For service to 2,000 psi, −20° to 225°F. Other types available for higher ratings. *Ask for Catalog Sheet 406.*

BARCO MANUFACTURING COMPANY

506N Hough Street • Barrington, Illinois

Circle 637 on Page 19

Increased Insulation

BETTER CONNECTIONS

JONES BARRIER TERMINAL STRIPS

Leakage path is increased — direct shorts from frayed terminal wires prevented by bakelite barriers placed between terminals. Binder screws and terminals brass, nickel-plated. Insulation, BM 120 molded bakelite. Finest construction. Add much to equipment's effect.

Jones Means Proven Quality

Illustrated: Screw Terminals—Screw and Solder Terminals—Screw Terminal above Panel with Solder Terminal below. Every type of connection.

Six series meet every requirement: No. 140, 5-40 screws; No. 141, 6-32 screws; No. 142, 8-32 screws; No. 150, 10-32 screws; No. 151, 12-32 screws; No. 152, ¼-28 screws.

Catalog No. 22 lists complete line of Barrier Strips, and other Jones Electrical Connecting Devices. Send for your copy.

Jones

HOWARD B. JONES DIVISION

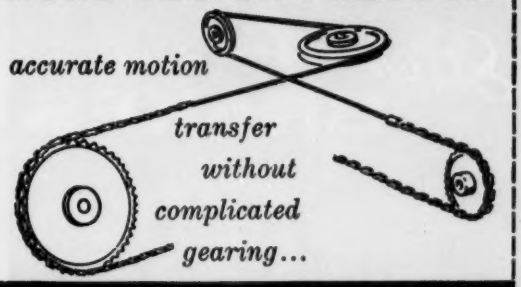
CINCH MANUFACTURING COMPANY

CHICAGO 24, ILLINOIS

DIVISION OF UNITED-CARR FASTENER CORP.

Circle 638 on Page 19

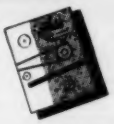
MORE DESIGN FREEDOM



SIERRA MINIATURE MECHANICAL CHAIN AND SPROCKETS...

Provide precise, positive motion transfer through several planes simultaneously with no cable slippage...no complicated gearing. Unlimited center-to-center selection for miniature and sub-miniature assemblies in servo systems, gyro systems, special cameras, electronic equipment, and small precision instruments. Less weight, cost, maintenance —wider tolerances. Designed to operate around minimum 7-tooth sprocket with root diameter of .250 inches. Chain pitch .1475 inches; Weight .45 oz. per lineal ft. Material: stainless steel, or other materials, including non-magnetic beryllium copper.

NEW CATALOG



Contains useful application data, specifications, tables on chain pitch and sprocket sizes, suggestions for calculating center-to-center distance. *Write for yours today.*

123 E. Montecito Avenue, Sierra Madre, California

Sierra ENGINEERING CO.

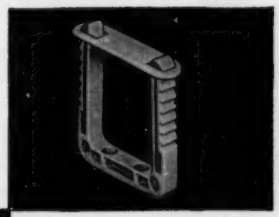
T. M. REG.

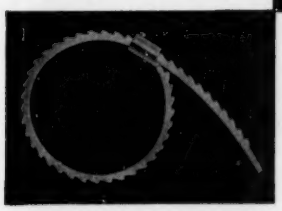
Circle 639 on Page 19

TO SECURE WIRES & WIRE BUNDLES

DAKOTA

Nylon CAB-L-TITE* CLAMPS and BUND-L-TITE* STRAPS





- Lightweight
- Fast and easy to install
- Positive holding power
- Versatile
- Reliable

Real weight and space savers, Dakota clamps and straps are made from DuPont zytel to insure extra strength, extra reliability under extreme loadings. Thoroughly proven in aircraft and missiles. Dakota securing devices find countless applications throughout industry. Bayonet hangers for fixed strap installations and high speed bundle-tie pliers are also available.

Get the facts today! Write for literature!

*A TRADEMARK OF DAKOTA ENGINEERING, INC.

DAKOTA ENGINEERING, INC.
4315 SEPULVEDA BLVD. • CULVER CITY, CALIFORNIA

Circle 640 on Page 19

NEW!

wear adjustment requirements eliminated on Magnetic Disc Brakes rated 125 to 575 lbs. ft. torque

DINGS

SELF-ADJUSTING BRAKES

Think of the maintenance money you'll save! *No* adjustment for wear is required on these new Dings "90M Series" magnetic Disc Brakes, even in the higher torque ratings. They *automatically* adjust for wear, practically eliminating maintenance until disc replacement is necessary.

High thermal capacity is another welcome Dings Brake feature. It means that Dings can give you brakes for combination brake-motors for high inertia loads or high frequency starts and stops.

Other outstanding features include: "Thru-Shaft" construction, standard and protected enclosures, automatic reset manual release, standard length NEMA shaft extension for hub mounting, Hevi-Duty discs, Taper-Lock non-slip hub, A.C. and D.C. coil energization.

Dings new Self-Adjusting Brakes are designed for "C" flange motor mounting on frames 324UC through 505C, or for foot mounting.

Dings Complete Line Solves Your Brake Problems

STANDARD *Direct-Acting* MAGNETIC DISC BRAKES

18 Models of Dings Standard Magnetic Brakes, with a torque range of 1½ to 175 lbs. ft., meet every requirement for smooth stops and dependable holding, with low maintenance. Available for "Thru-Shaft" applications.

HAZARDOUS-LOCATION MAGNETIC DISC BRAKES

Dings Hazardous-Location features are tested and approved by Underwriters Laboratories. The "707" Series models are for Class I, Group D. The "709" Series are for Class I, Groups C and D, and Class II, Groups E, F, G.

MAGNETICALLY ENGAGED CLUTCH COUPLINGS

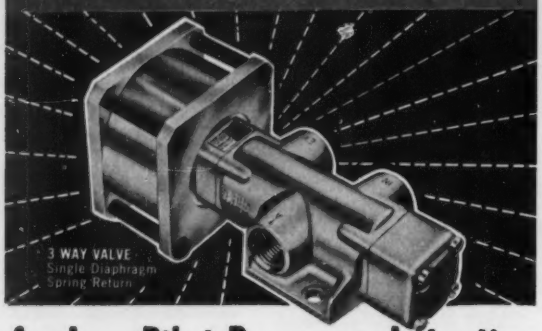
This low-inertia, positive engagement clutch coupling utilizes serrated teeth for transmitting high torques without slippage. Meets a wide range of applications, with ratings from 1200 through 32,000 lb. ft. torque. DB-258½

Take advantage of Dings complete engineering service for your brake or clutch problems. Write or phone today.

DINGS BRAKES, Inc.
A Subsidiary of Dings Magnetic Separator Co.
4714 West Electric Ave., Milwaukee 46, Wis.

Circle 641 on Page 19

VERSA Diaphragm Actuated Valves



for Low Pilot Pressure Actuation

■ Versa Diaphragm Valves can be actuated by pilot (or signal) pressures as low as 5 PSI on double diaphragm types and as low as 10 PSI on standard spring return models.

Versa Diaphragm Valves are available with side port bodies or for manifold mounting, and in sizes from 1/8" thru 1" NPT in 2-, 3-, 4-, and 5-way types, and for pressures from partial vacuum to 500 PSIG.

All Versa Valves are triple pressure and functionally tested under water for guaranteed leakproofness.

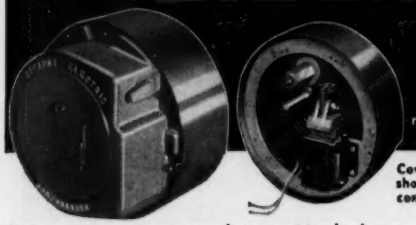
VERSA

■ Write Today for your free copy of bulletin 259

VERSA PRODUCTS COMPANY INC.
347 SCHOLES STREET
BROOKLYN 6, N. Y.

Circle 642 on Page 19

NEW "42,000 series" Stearnetic* DISC BRAKES



(The choice of leading electric motor manufacturers)

Cover removed to show Stearnetic* construction.

* *Stearnetic* — Stearns exclusive unitized, electro-magnetic operating mechanism.

- Up to 33% shorter
- Up to 50% lighter
- Max. torque 125 to 575 lb ft
- AC or DC—all single phase — only 2 lead wires
- For standard or straight-thru shafts
- Standard motor or floor mounting — two styles of enclosure
- Exclusive Stearns 1-point adjustment for wear
- Variable torque to match application

Send for Special Information Sheet No. 2-F

Stearns ELECTRIC CORPORATION
120 NORTH BROADWAY
MILWAUKEE 2, WISCONSIN
Phone: BRoadway 2-1100

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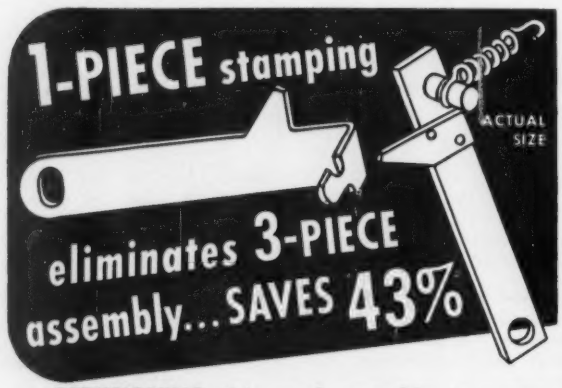
1-PIECE stamping



eliminates 3-PIECE assembly... SAVES 43%

REDESIGNING this pawl assembly to a one-piece stamping gave the customer exact duplication plus lower cost. Formerly fabricated at $1.00 each, the first 100 stampings cost 57¢ each. The next 100 pieces will show a savings of 95%.

Got a fabrication problem? Chances are it can be solved with short-run stampings using the D-R method of utilizing temporary tooling. Send your print and/or sample, plus quantity, for prompt quotation. No obligation.

DAYTON ROGERS
Manufacturing Company

MINNEAPOLIS 7C, MINNESOTA

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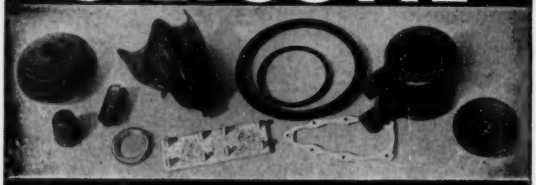
SILICONE



MOLDED RUBBER PARTS

Resist Temperatures from +600°F to −140°F

Custom-Compounded to your own specifications

By using the versatile Silicone gums, we formulate our own compound to arrive at the specific property or properties required for each individual application. Frequently, a lower cost formulation can be used which will perform in the particular application as well or better than any standard pre-mixed stock available.

Send for list of informative Silicone Rubber Brochures.

Also available—Acushnet Rubber Data Handbook.

Each order can now be tailor-made to fit the customers' own specifications. As a result, production time is reduced, product performance is improved, and cost is lowered in many applications.

Acushnet — Wide range of heat-resistant and low shrinkage Silicone compounds available.

Address all communications to 762 Belleville Ave., New Bedford, Mass.

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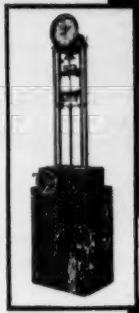
THE ULTIMATE
in testing perfection
Dillon
UNIVERSAL TESTERS

Here's a low cost tester that operates in tensile, compression, transverse or shear. This inexpensive instrument can make *hundreds* of accurate checks daily on metal, plastics, wire, rubber, springs, etc. Handles round, flat or special shapes. More than 15 gripping fixtures available. Max. indicator. Self-aligning grips. Hand wheel operated or motorized. Meet ASTM & Fed. specs. Rugged & fast. Calibrated with certified dead weights. Recorder optional. Max. capacity 300 lbs.



MODEL L. Heavier unit for materials up to 125,000 lbs. PSI. 7 interchangeable gauges provide wide range.

MODEL M. For low strength materials between 0 & 300 lbs. Pendulum-type with 5 scales.

Write For brochures and LOW price schedule today!

W.C. Dillon & CO., INC.
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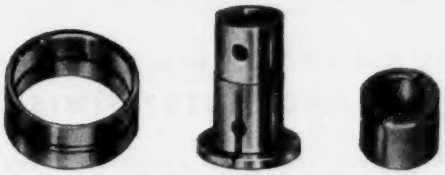
Moccasin BRONZE SLEEVE BEARINGS

Specialists in Special
CAST BRONZE BEARINGS



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Any Quantity — Any Size
Wide range of alloys poured to all specifications

SPECIFY BRONZE BEARINGS
Longest life and low cost • Quietness and wide availability
Low fluid friction, high fatigue and compressive strength
Write for Free Design Engineering Information

MOCCASIN BUSHING CO.
"Quality Bronze Since 1908"
MEMBER OF CAST BRONZE BEARING INSTITUTE
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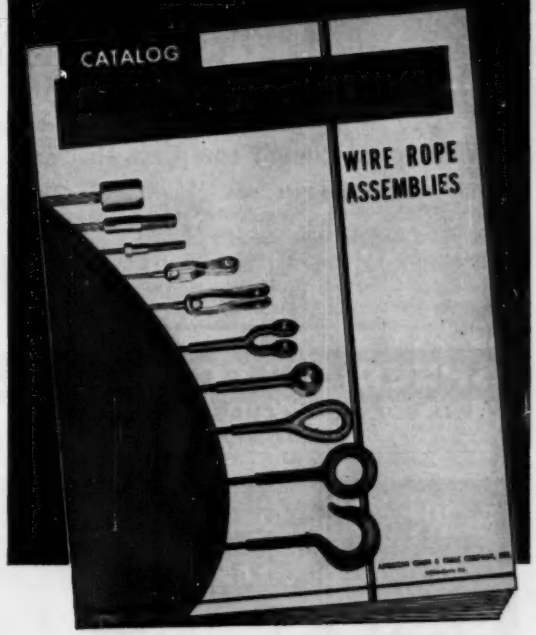
Circle 647 on Page 19

FREE REFERENCE CATALOG
Tru-Loc Wire Rope Assemblies



Standard Tru-Loc Assemblies provide compact, efficient connections at less cost!

• Use this 28-page reference catalog to help simplify many tough design problems. See the variety of Tru-Loc Assemblies possible with Preformed wire rope and swaged fittings. They cut costs, simplify assembly, save space and improve the appearance of products. Send for your **FREE** catalog today and find out how one or more of these assemblies will fit your specific requirements. Catalog contains photographs, engineering drawings, dimensions—and it's all been clearly condensed and charted for easy reference.

FILL IN COUPON BELOW AND MAIL TODAY!

American Chain & Cable Company, Inc. MD
Wilkes-Barre, Pennsylvania
Please forward my free copy of your New 28-page catalog TL-500 on Tru-Loc Wire Rope Assemblies

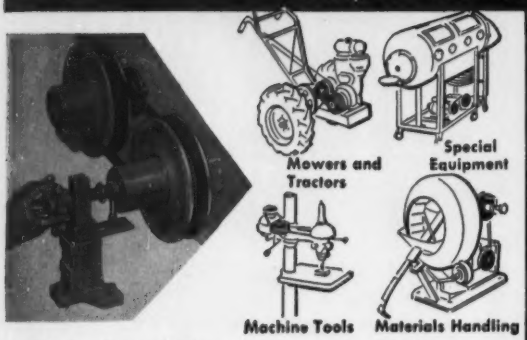
Name_____
Company_____
Address_____
City_____ Zone____ State_____

Circle 648 on Page 19

SPEED SELECTOR

VARIABLE PITCH SHEAVES

Control Speeds on Variety of Machines



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Speed Selector Sheaves can give your machines or equipment extra wide-range speed control on fixed centers. Efficient, rugged, simple to use — low in cost! Write for Illustrated Bulletin.

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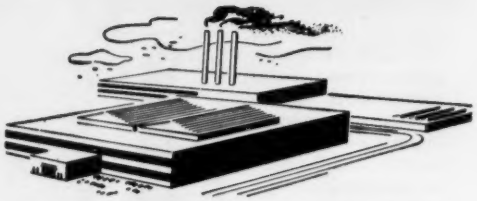
INDUSTRIAL* FELT ?



NOW! Synthetic Fiber Felts and Wool Felts designed for exacting, special applications!

NOW! Available CUT to meet your specifications!

NOW! Large diversified inventory insures prompt delivery!

*Available in all weights, widths, colors, etc. and made to S.A.E. and Federal Gov't. Specifications.

FREE Folder of samples and applications of Industrial Felt. Write for Booklet K-4.

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Circle 650 on Page 19

new! *Weckesser* nylon

Wedge Lock

BAND CLAMP

Patent Pending
TWO-POSITION WEDGE PERMITS ADJUSTMENT FOR TEMPORARY ASSEMBLY . . .
Wedge In First Position
Wedge In Locked Position
BUT . . . ONCE IT'S LOCKED, YOU'VE GOT TO CUT IT LOOSE!

• Another Weckesser "first" • Just introduced at the I.R.E. Show • First *practical* band clamp that locks and holds permanently • Solid DuPont Zytel 101 (Nylon) • Easy assembly with screwdriver or forked tool—One size for cable diameters ⅛" to 1¾"

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Manufacturers of Nylon, Teflon and Ethocel Cable Clamps, Molded Nylon Screws and Nuts, Nylon Threaded Rod and Washers.

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Circle 651 on Page 19

WHAT'S YOUR PROBLEM ?

PARTS? MATERIALS? COMPONENTS? FINISHES?

Perhaps one of our advertisers in this issue of MACHINE DESIGN has the solution to your dilemma. We'll be willing to bet that this issue contains information that is essential to answering your problem.

Fill out one of the yellow inquiry cards and send it to us. No letter or postage is necessary. We will forward your inquiry to the advertiser and he will reply directly to you

Why not do it right now?

USE THE YELLOW CARD ON PAGE 19.

When it's a Question of

"O" RINGS in any material or special compound for every service condition required.

PACKINGS to your specifications in leather, synthetics, asbestos, teflon, etc.

Also gaskets and washers in over 200 materials...

Look for the Answer at Auburn...

Send us your specifications or blueprints. You'll receive prompt quotations and recommendations without obligation

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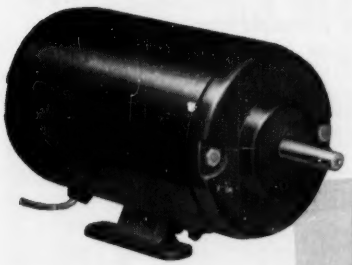
Circle 652 on Page 19

FHP motors... engineered especially for your product



The new RAE M-40 Series, in 3 ratings at 5000 RPM. AC/DC Universal or DC Shunt. M-41 and M-42 rated ½ H.P. M-43 and M-44 rated ¾ H.P. M-45 and M-46 rated 1 H.P. Available with any of Rae's gear units.

RAE motors

RAE engineers are recognized specialists in solving difficult FHP motor applications. By careful analysis and testing of your product, they can save you time and money in selecting the right motor.

RAE offers outstanding service and quality in a large variety of motors. Available in voltages up to 250, and up to 1/2 H.P. (higher for intermittent duty) with many gearhead motor combinations.

Find out how RAE motors can *improve your product* and *reduce costs* as they are doing for other leading manufacturers.

***Send for the "RAE" Engineering Data Sheet. It will help you supply the data necessary for recommendations and prices.**

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2009 Kewaunee Street
Racine, Wisconsin

AC/DC Universal • DC Shunt Wound • DC Series Wound • Gear Reduction Motors • Governor Controlled Motors • Motors for Rheostat Control • Motors for Electronic Control • Permanent Magnet Motors and Gearmotors.

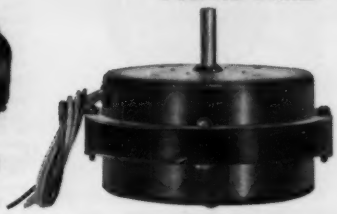
Circle 653 on Page 19

from **DALOHM**
better things in smaller packages

NEW BREAKTHROUGH IN HYSTERESIS MOTOR DESIGN GIVES LOWEST HEAT RISE

Frame HMD

Frame HM



Frame HMB

Priced competitively with any similar U. S. or foreign motor.

• Sub-Fractional • Lowest Cost • No Vibration • Synchronous

The new DALOHM hysteresis motor provides all the desirable characteristics of such motors, yet doesn't have the usual heat rise handicaps. Small and light-weight, its new pancake configuration is space saving.

Low cost is achieved by advanced design and production techniques. It is more economical to use because it uses a smaller capacitor than comparable motors.

Ideally suited for facsimile machines, Hi-Fi turntables, tape recorders, tele-metering and many other types of equipment where constant synchronous speed is essential.

- Low noise
- Maintains synchronous speed at rated load
- No vibrations or magnetic strays
- Reaches full RPM in one revolution
- Exceptionally low cost
- Will start at voltages as low as 100 volts, and will operate from 100-120 volts

RUNNING TORQUE: 1.9 in./oz. to 28 in./oz.

VOLTAGE: 115 V., 60 c.p.s.

SPEED: 1800 RPM (variable with frequency)

HORSEPOWER: 1/20th to 1/300th

Write for Bulletin R-80

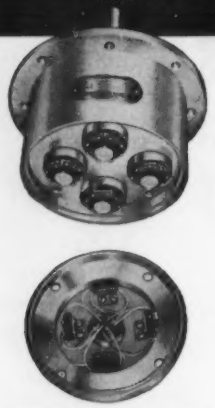
SPECIAL PROBLEMS?

You can depend on DALOHM, too, for help in solving any special problem in the realm of development, engineering, design and production. Chances are you can find the answer in our standard line of precision resistors (wire wound, metal film and deposited carbon); trimmer potentiometers; resistor networks; collet-fitting knobs; and hysteresis motors. If not, just outline your specific situation.

DALE PRODUCTS INC.
1368 28th Ave.
Columbus, Nebraska

Circle 654 on Page 19

One Device Detects & Controls
MULTIPLE SPEEDS
• ACCURATELY • POSITIVELY • RELIABLY
SYNCROSNAP MULTI-TECTOR



Syncro-Snap MULTI-TECTOR detects and controls as many as eight separate circuits, and actuation can be accomplished on a high and low speed limit on each circuit.

For instance, inter-related speeds on automated systems can be synchronized. Machine tool speeds can be controlled as accurately as ¼ of 1%. Speeds of various components in aircraft and missiles can be sequenced or synchronized. Separate drives on equipment, such as large printing presses, can be actuated at predetermined speeds. A typical use is a four-stage MULTI-TECTOR on diesel engines which (1) cuts out cranking motor, (2) actuates cooling circuit, (3) controls fuel requirements, and (4) signals full speed and "too-low" speed.

MULTI-TECTOR measures only 5" in diameter x 4" deep. Housing is standard to provide maximum economy. Individual Syncro-Snap switches used in the MULTI-TECTOR operate on speed alone, regardless of voltage or load. They possess a life expectancy of 1.5 to 3 million cycles, with no signs of frictional wear and no variance in operating characteristics. Send requirements today for quotations.

covered by patents and patents pending.

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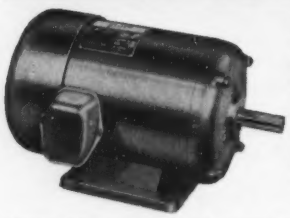
You Get MORE with
DOERR MOTORS



QUALITY...
Top performance and life.
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Solves toughest problems.
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Even on small-lot orders.

YOUR PRODUCTS are *easier to produce . . . easier to sell* . . . with a Doerr motor as original equipment.

Got a problem? Doerr's experience with thousands of "specials" suggests quick, economical answers. Our broad background helps develop practical new designs to fit all of your requirements at lowest cost.

Also, Doerr quality construction assures full performance of your product . . . while compact, modern Doerr styling adds to appearance.

CALL DOERR WHEN YOU NEED MOTORS

On your next call for motors, get MORE . . . contact DOERR! Expanded line includes ratings from 1/30 to 15 hp. Specials are our specialty—backed by nation-wide, expert field service. Phone Cedarburg 801 or write . . .

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Wanted: Engineers

with an interest in writing

Like to break into an interesting field where you'll make good use of your engineering talents — yet have a chance to develop new skills?

We're looking for several men with engineering experience and a yearning to write or edit. As an editor on MACHINE DESIGN, you would broaden your engineering background in a job that provides stimulating contact with people in many engineering areas.

You don't have to have actual writing or editing job experience, although we expect definite ability in handling the English language. An ME or EE degree plus several years of design-engineering experience would be ideal, but we'll be happy to consider equivalent qualifications. Age: 25 to 35.

If you've worked in a design-engineering specialty area, we'd like to hear about it. We're interested in any job experience or training in:

- Mechanical drives, controls, systems
- Mechanical components, assemblies
- Electrical or electronic drives, controls, systems
- Hydraulic or pneumatic systems, drives, controls
- Materials and finishes selection or specification
- Design for manufacture or production design

Our headquarters are in Cleveland. There is opportunity for travel to engineering meetings, expositions, and manufacturing companies. Salary will depend on your background and experience.

If you are interested, send a resume of your engineering background, and any evidence you may have of writing ability (we'll return this if you wish) to: Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

MACHINE DESIGN

Circle 656 on Page 19

FIRST

in performance • durability • economy

BENDIX ELECTRIC FUEL PUMP PAYS OFF IN PERFORMANCE

When your job calls for a fuel pump, think first of Bendix. Over the years the Bendix* Electric Fuel Pump has proved itself with outstanding, dependable performance under stress conditions. In tests conducted under U. S. military supervision, it functioned efficiently at temperatures ranging from +114° F. to −76° F. The Bendix pump is easy to install and service, has a built-in pressure release, delivers more gallons per hour, and *positively prevents vapor lock.* To repeat, the Bendix Electric Fuel Pump pays off in performance. Write for descriptive folder and specifications.

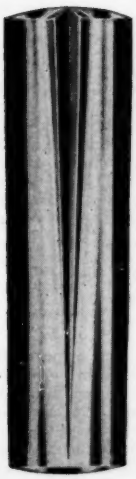
*Reg. U. S. Pat. Off.

Bendix-Elmira
Eclipse Machine Division
Elmira, New York

Bendix
AVIATION CORPORATION

Circle 657 on Page 19

need DRIV-LOK grooved pins in SPECIAL MATERIALS?



- aluminum
- alloy steel-heat treated
- brass
- stainless-303 and 416
- bronze

DRIV-LOK Pins — the positive locking, solid steel body grooved fasteners — are also available in a variety of special materials to meet particular requirements of strength, corrosion resistance, electrical qualities, or combinations of these properties. Like all DRIV-LOK Pins, they are carefully made to exacting standards, are easy to install and will reduce your fastening and assembly costs.

Write us, describing your fastening requirements. Recommendations made and catalog sent without obligation.

DRIV-LOK SALES CORPORATION
715 Park Avenue • Sycamore, Illinois

Circle 658 on Page 19

REMOTE BULB, INDICATING TEMPERATURE CONTROL E32N

Featuring Control Point Accuracy Equivalent to Individually Calibrated Instruments

The **UNITED ELECTRIC** Type E32N Temperature Control is a uniquely designed instrument that is used to control and indicate temperatures of gases, liquids or hot plates over wide ranges. This unit contains a 12-inch scale for easily read visual indications. It is possible to replace the thermal unit in the field without any loss of calibration accuracy.

Temperature Ranges	−150°F. to 150°F., 70°F. to 370°F., 100°F. to 650°F. Read temperature on continuous, 12-inch indicating scale that rotates against a fixed index pointer in a vertical and centered location.
Switch Ratings	Up to 15 amps. at 115 or 230 volts A.C. 20 amp. A.C. or D.C. switches also available.
Switch Types	N.O., N.C., or Double Throw — no neutral position.
On-Off Differential	Approximately 1.0°F. or 2.0°F. dependent on model.
Adjustment	Calibrated dial rotated against a fixed index.
Calibration	Calibrating mechanism permits precise matching of scale to individual tolerance errors of thermal assemblies.
Compensation	Automatic compensation for ambient temperatures.

UNITED ELECTRIC manufactures a complete line of temperature, pressure, and vacuum controls. For applications requiring custom-built units or modified standard units, call upon a UE application engineer for recommendations. Complete data is available for the Type E32N as well as for all standard UE controls.

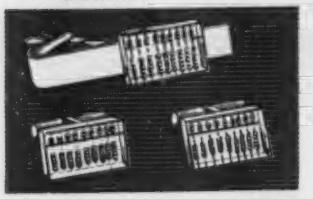
United Electric Controls
COMPANY
85 SCHOOL STREET, WATERTOWN, MASS.

Circle 659 on Page 19

TALK ABOUT . . . "CONVERSATION PIECES"

for the MAN in INDUSTRY

They not only "look" like "the real thing"—THEY ARE the REAL THING!



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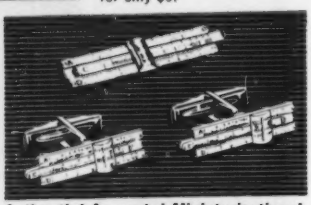
Authentically miniaturized in the most infinite detail down to the individual beads! Everything counts! Everything works — links and clasp! All in beautiful STERLING SILVER: tie clasp $5.* each; cuff links, $5. the pair or the complete set of tie clasp and cuff links for only $9.*

SLIDE RULE TIE CLASP SET

We defy comparison! Look at these details: scales A, C and D! cursor with magnifier! 2" long x 7/16 wide x 3/64 thick! Slide rule tie clasp in STERLING SILVER, only $3.95 each*; matching cuff links (non-operative), $3.95 the pair; or complete set of clasp and links, $7.50. In gold or silver plate (please specify): tie clasp, $1.75 each and cuff links, $1.75 the pair; or $3.25 for the complete set of clasp and links.



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The **FRED KLEIN** *Company, Dept. MD12,*

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PRECISION CAM ADJUSTMENT *WITH A SCREW DRIVER . . .* **IN SECONDS!**

One type cam . . . no special cam lobes required.

Snap Action Switches, N. O. and N. C.—electrically separated

2 through 12 circuits. Available in NEMA 1, 4, 5, 7, 9 and 12 enclosures.

Please send Bulletin 558 for complete story of new Gemco Rotating Cam Limit Switches.

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75 oz. in. recommended max load at 2,500 rpm 0.3 oz. in. breakaway torque

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Send for 16 pg. Supplement "C" to Dynaco E88 Catalog. Shows complete line & specs. on Precision Stock Differentials including Precision Hollow & Solid Shafts, Bearingless, Face Gear and 3-Gear Models.

DYNAMIC GEAR CO. INC. AMITYVILLE, NEW YORK

Circle 660 on Page 19

ENGINEERS AVAILABLE OR WANTED

AVAILABLE: Sales Engineer to sell your product in the heavily concentrated Cleveland, Pittsburgh, Buffalo metalworking market. Age 35; aggressive, with top level technical sales experience. Heavy background in all phases of metalworking plus real sales planning and programming ability. Accustomed to five figure earnings on straight commission or salary and will work either way for the right company. Reply Box 958, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

WANTED: Senior Design Engineer. Excellent opportunity for a Senior Design Engineer in the challenging field of Mechanical Development for a Graduate Engineer who can assume the full responsibilities for the design and development of special machines and mechanical equipment. Must exercise ingenuity and creative thinking in deriving solutions to assigned projects. Long term opportunities with an expanding pharmaceutical firm offering a broad program of employee benefits and excellent working conditions. Send complete resume, including salary requirements to Box 959, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

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BPA NBP

backtalk——

——Do-It-Yourself Gunnery

Hitting a moving target with a gun carried on a bouncing conveyance isn't as easy as the good guys in westerns make it look. Thus, it seems highly probable that eager acceptance would greet any invention to improve accuracy. Yet, in "A Position Servo," Page 134, we learn that the device described by Mr. Tower in 1889 was rejected by Her Majesty's Admiral, Sir John Hay. He felt that "the Naval gunner should simply and directly be taught to discharge his gun considering all the various contingencies of the movement of the muzzle . . . and the change of position of the ship and the change in position of the object . . . to hit his mark." Even in those days, war was you-know-what; apparently Sir John meant to keep it that way.

——Magazine Makers

It is our privilege to introduce a new name, and a new title for an "old" name. The newcomer is John Hostak, who spent the last four years at the American Gas Association, where he was a test engineer, then a research engineer in the American Standards requirements investigation department. Before his stint with the AGA, John held an assortment of jobs, all of which convinced him he should go into engineering. He studied engineering at Ohio State and is currently working toward a degree in physics via night courses at John Carroll University in Cleveland. When he's not editing articles, attending classes, or doing homework, John likes to curl up with a good book on psychology or philosophy. A well-rounded sort, he also bowls, plays golf, and listens to semiclassical music.

Jim Parks, who is now happily passing out new calling cards which read "Associate Editor," joined MACHINE DESIGN not quite two years ago. He holds a degree in civil engineering from Ohio Northern University, Ada, Ohio, and worked at Pesco Products Div. of Borg-Warner in the research and development section. If Jim appears a bit smudgy it's only because one of his extra-curricular activities required his wearing black-face make-up for several successive evenings recently. He was an end-man in a minstrel show, which he also helped to write and direct. Jim's writing for MACHINE DESIGN calls on a different sort of talent—he is responsible for the "Scanning" pages and oversees most of our articles dealing with fluid power.

——Wanted: Info on UFO

The following request appeared in our "In" basket the other day:

> I am interested in the subject of flying saucers. If you have any literature on this subject would you be kind enough to forward it to me. If you do not have any information would you please tell me where I could acquire it.

The subject of flying saucers is one which MACHINE DESIGN has not covered extensively. As interested individuals, we read about them, and we are referring our inquirer to some familiar books. But we wonder if any Backtalk readers might be authorities on flying saucers. If you've got any good, solid technical information on UFOs, let us know—we'd like to pass it along.

Vibration

With "The Mobility Method" on Page 144 of this issue, we begin a program of design-analysis articles on dynamic loading, such as vibration. In the words of Leo Spector, who edited R. P. Thorn's articles, it's at best "a real hairy subject." The mobility method of setting up mechanical systems *a la* electrical-circuit design defuzzes the subject somewhat by permitting the use of algebraic equations instead of partial differential equations.

After these two articles, treatment to reduce shake, rattle, and rumble will continue in a series on dynamic analysis by mobility and impedance methods written by A. H. Church of New York University.

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Circle 662 on Page 19→

After years... if you do have to "repack"

JUST REPLACE 2 SELF-CONTAINED UNITS

IF IT'S A HUNT PDQ AIR VALVE

You want an air control valve that **one man can completely repack in a minute** on the bench or on the line.

We have that valve for you.

To repack the HUNT PDQ you just slide two simple self-contained units into place. One . . . the poppet spindle-sleeve assembly. Two . . . the plug-in solenoid pilot assembly. That's all!

You want a minimum inventory of spare parts. With the HUNT PDQ valve you stock **only two spare units** . . . not several dozen parts.

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- ☑ Accessibility
- ☑ Simplicity
- ☐ Speed and Capacity
- ☐ Price and Quality

The Hunt PDQ valve tops them all in every class.

Next month . . .
the SPEED and CAPACITY story.

HUNT V H C ***Quick-As-Wink*** AIR & HYDRAULIC CONTROL VALVES

here's the really new

Cleveland Worm and Gear

SPEED REDUCER

It was Designed to Provide: High Horsepower in a Smaller Unit • Centrifugally Cast Bronze Gears • Alloy Steel Worms Heat Treated By An Exclusive Process for Carrying Higher Loads • Fan Cooling for More Efficient Operation • Maximum Overhung Load-Carrying Capacity • Ribbed Housing for Maximum Strength and Heat Dissipation • Modern, Streamlined Design to Enhance Your Machine's Appearance.

Cleveland's new speed reducer line meets AGMA Standard 440.03 — which permits higher horsepower and torque ratings — provides you speed reduction at savings of 50% or more on cost per horsepower. All this, with no deviation from Cleveland's standards of quality and dependability.

Remember, this strikingly new line of fan-cooled reducers — now available from one to forty horsepower — incorporates all the design knowledge gained by Cleveland's engineers over the past 47 years — plus all the advantages of modern metallurgical techniques and advanced manufacturing processes. Consult your Cleveland Representative for the complete story on this new speed reducer — or write us direct for Bulletin No. 405. It details input horsepower and output torque ratings, service factors, application and load classifications, as well as general over-all dimensions. **The Cleveland Worm & Gear Company, 3287 East 80th Street, Cleveland 4, Ohio.**

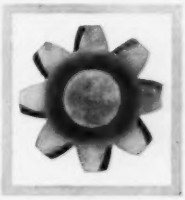
A subsidiary of
Eaton Manufacturing Company
Affiliate: The Farval Corporation

EATON

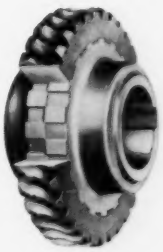
CLEVELAND
Worm Gear
Speed Reducers

Check these new exclusive Cleveland features

Cleveland's Worm's, heat-treated by an exclusive process, possess a high degree of hardness throughout their entire thread thickness — and well below the worm's root diameter. This gives maximum thread strength and resistance to wear without losing the advantage of a tough core of medium hardness.



Centrifugal cast bronze rims have a greater density and a higher hardness, giving increased resistance to wear and fatigue pitting. They are centrifugally cast integral with cast iron centers on 6″ and smaller sizes. This permits strong mechanical keying of the two parts — without dependence on actual surface bond. Gear shaft extension diameters are especially large to permit greatly increased overhung load capacity.



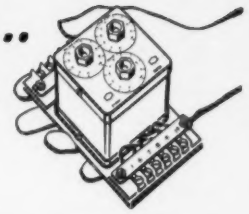
Worm and gear shaft bearings are Timken taper roller type, providing adequate thrust and radial capacity. Worm bearings are mounted directly in the housing bore for greater rigidity.

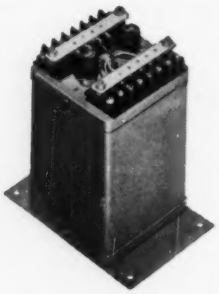
←Circle 662 on Page 19

Circle 402 on Page 19

another Cutler-Hammer *first...*

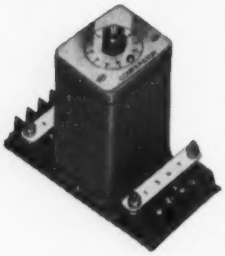
STATIC-POWERED TRANSISTORIZED REGULATOR MODULES



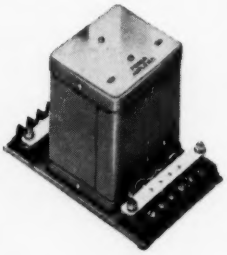


POWER SUPPLY Provides static power conversion of A-c line voltage into two channels of D-c, one to power other modules, the other is used as a regulated reference voltage. Available in several sizes.

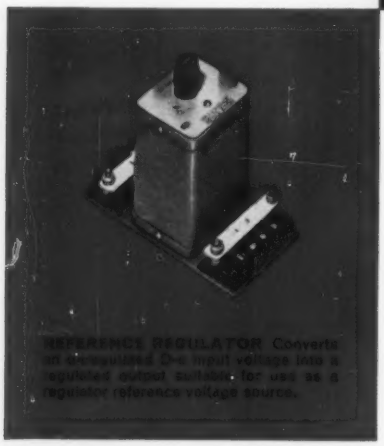
To simplify the design and assembly of the regulating systems for the Ultraflex Adjustable Speed Packaged Drive, Cutler-Hammer developed a complete line of compact regulator modules. These units provide a new economical, time-saving "building-block" approach to the fabrication of speed regulators, current regulators, etc. All modules are static, transistorized, and encapsulated for maximum reliability and space-saving compactness. No electronic tubes are used. Terminal-board wiring between modules, front-adjusting potentiometers, and easy-access fuses are plus features that speed assembly operation and maintenance. Write today for the new descriptive Bulletin ED102- Y243. Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

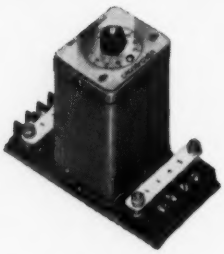


COMPARATOR This adjustable gain amplifier monitors a feedback signal, compares it with a reference input, then generates a corrective output error signal.

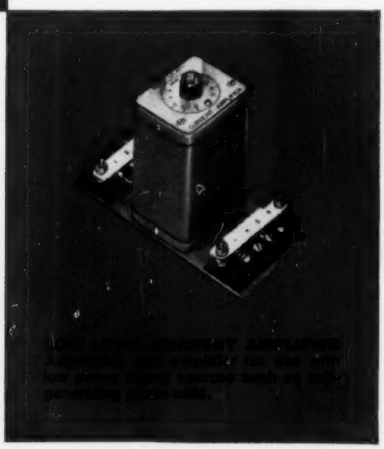


POWER AMPLIFIER Amplifies the output voltages from other modules when a stronger signal is required . . . frequently used as a pre-amp to magnetic amplifiers.





CROSS-OVER Designed to progressively regulate both the armature voltage and shunt field excitation, the cross-over converts a single input into two output signals.



CUTLER-HAMMER CONTROL

CUTLER-HAMMER

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